Altibase Application Development

Precompiler User's Manual

Release 6.1.1

February 4, 2013

Altibase Application Development Precompiler User's Manual

Release 6.1.1

Altibase Corporation

10F, Daerung PostTower II, 182-13,

Guro-dong Guro-gu Seoul, 152-847, Korea

Telephone: +82-2-2082-1000 Fax: 82-2-2082-1099

Homepage: http://www.altibase.com

Contents

Preface

About This Manual

This manual explains how to use the embedded SQL statement of ALTIBASE® HDB™ and C/C++ precompiler. The user can create an application using the embedded SQL statement of ALTIBASE HDB and precompile the created program.

Audience

This manual has been prepared for the following ALTIBASE HDB users:

- Database administrators
- Performance managers
- Database users
- Application developers
- Programmers
- Technical support workers

It is recommended that those reading this manual possess the following background knowledge:

- Basic knowledge in the use of computers, operating systems, and operating system utilities
- Experience in using relational databases and an understanding of database concepts
- Computer programming experience
- Experience in database server, operating system or network administration

Software Environment

This manual has been prepared assuming that ALTIBASE HDB 6 will be used as the database server.

Organization

This manual is organized as follows:

- Chapter1: New Features in APRE C/C++

  This section describes the new features that were introduced with APRE in ALTIBASE HDB 5.3.3.

- Chapter2: The C/C++ Precompiler

  This chapter presents an introduction to the C/C++ precompiler and how to use it, and gives a detailed description of the procedure for writing applications that contain embedded SQL statements.

- Chapter3: Host Variables and Indicator Variables

This chapter describes both host variables and indicator variables, and explains how to interpret the meaning of indicator variables.

- Chapter4: Host Variable Declaration Section

  This chapter explains both the host variable declaration section and the function argument declaration section.

- Chapter5: C Preprocessor

- Chapter6: Host Variable Data Types

  This chapter describes the data types that are used for host variables.

- Chapter7: Embedded SQL Statements

  This chapter explains how to use embedded SQL statements, including those for managing database connections and executing DDL and DML statements.

- Chapter8: Handling Runtime Errors

  This chapter explains how to use the standard variables for handling runtime errors.

- Chapter9: Using Cursors

  This chapter explains the statements used to manage cursors.

- Chapter10: Using Arrays in Embedded SQL Statements

  This chapter covers how to use array-type host variables and discusses arrays of structures and the limitations on their use.

- Chapter11: Dynamic SQL Statements

  This chapter explains dynamic SQL statements.

- Chapter12: Using Stored Procedures in C/C++

  This chapter describes how to use stored functions and stored procedures.

- Chapter13: Applications with Multiple Database Connections

  This chapter covers how to write applications that use multiple database connections.

- Chapter14: Multithreaded Applications

  This chapter discusses how to write multithreaded applications.

- Chapter15: Error Codes and Messages

  This chapter explains the APRE error codes and messages.

- Appendix A. Using Files and LOBs

  This chapter explains how to store LOB-type data in the file system.

- Appendix B. Porting Pro*C Applications to APRE

This chapter discusses how to convert applications written with Oracle Pro*C(C++) to APRE.

- Appendix C. Sample Applications

  This chapter explains the location of the sample applications.

- Appendix D. FAQ

  This chapter lists frequently asked questions about how to use APRE and embedded SQL statements.

Documentation Conventions

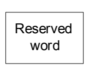
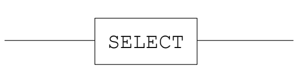
This section describes the conventions used in this manual. Understanding these conventions will make it easier to find information in this manual and in the other manuals in the series.

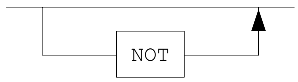
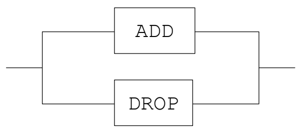
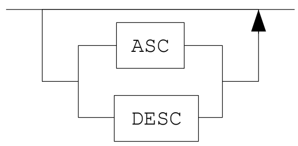
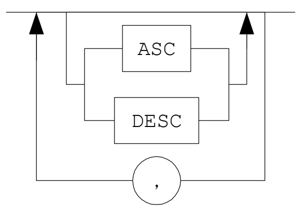
There are two sets of conventions:

- Syntax Diagram Conventions
- Sample Code Conventions

Syntax Diagram Conventions

In this manual, the syntax of commands is described using diagrams composed of the following elements:

Element	Description
	Indicates the start of a command. If a syntactic element starts with an arrow, it is not a complete command.
	Indicates that the command continues to the next line. If a syntactic element ends with this symbol, it is not a complete command.
	Indicates that the command continues from the previous line. If a syntactic element starts with this symbol, it is not a complete command.
	Indicates the end of a statement.
	Indicates a mandatory element.

Element	Description
	Indicates an optional element.
	Indicates a mandatory element comprised of options. One, and only one, option must be specified.
	Indicates an optional element comprised of options.
	Indicates an optional element in which multiple elements may be specified. A comma must precede all but the first element.

Sample Code Conventions

The code examples explain SQL statements, stored procedures, iSQL statements, and other command line syntax.

The following table describes the printing conventions used in the code examples.

Convention	Meaning	Example
[ ]	Indicates an optional item.	`VARCHAR [(size)] [[FIXED |] VARIABLE]`
{ }	Indicates a mandatory field for which one or more items must be selected.	`{ ENABLE | DISABLE | COMPILE }`
|	A delimiter between optional or mandatory arguments.	`{ ENABLE | DISABLE | COMPILE }` `[ ENABLE | DISABLE | COMPILE ]`

Convention	Meaning	Example

.
.
.
	Indicates that the previous argument is repeated, or that sample code has been omitted.	`iSQL> select e_lastname from employees;`
		`E_LASTNAME`
		`------------------------`
		`Moon`
		`Davenport`
		`Kobain`
		`.`
		`.`
		`.`
		`20 rows selected.`

Other symbols	Symbols other than those shown above are part of the actual code.	`EXEC :p1 := 1;` `acc NUMBER(11,2);`
Italics	Statement elements in italics indicate variables and special values specified by the user.	`SELECT * FROM table_name;` `CONNECT` *`userID/password`*`;`
Lower Case Letters	Indicate program elements set by the user, such as table names, column names, file names, etc.	`SELECT e_lastname FROM employees;`
Upper Case Letters	Keywords and all elements provided by the system appear in upper case.	`DESC SYSTEM_.SYS_INDICES_;`

Related Reading

For additional technical information, please refer to the following manuals:

- ALTIBASE HDB Getting Started
- ALTIBASE HDB Administrator's Manual
- ALTIBASE HDB ODBC Reference
- ALTIBASE HDB SQL Reference
- ALTIBASE HDB Application Program Interface User's Manual
- ALTIBASE HDB iSQL User's Manual
- ALTIBASE HDB Error Message Reference

Online Manuals

Online versions of our manuals (PDF or HTML) are available from the Altibase Customer Support (http://support.altibase.com/).

Altibase Welcomes Your Comments

Please feel free to send us your comments and suggestions regarding this manual. Your comments and suggestions are important to us, and may be used to improve future versions of the manual.

When you send your feedback, please make sure to include the following information:

- The name and version of the manual that you are using
- Any comments that you have about the manual
- Your full name, address, and phone number

For immediate assistance with technical issues, please contact the Altibase Customer Support (http://support.altibase.com/).

We always appreciate your comments and suggestions.

1 New Features in APRE C/C++

This section describes the new features that were introduced with version 5.3.3 of the APRE C/C++ Precompiler.

1.1 New Precompiler Features in ALTIBASE HDB 5.3.3

This chapter explains the new features that were added to the APRE C/C++ Precompiler in ALTIBASE HDB 5.3.3 ("APRE"). In ALTIBASE HDB 5.3.1 and earlier, the precompiler was known as the SESC C/C++ Precompiler. The name change to APRE reflects the large number of improvements and increases to functionality that were introduced with ALTIBASE HDB 5.3.3.

This chapter will be of particular interest to those who are porting development projects from SESC to APRE.

1.1.1 New Features

1.1.1.1 More Flexible Host Variable Declaration

It is now possible to use all variables as host variables, even if they were declared outside of the host variable declaration section.

1.1.1.2 Additional Preprocessor Directive Support

APRE now supports preprocessor directives such as #if, #ifdef, etc. For detailed information on the support for preprocessor directives, please refer to Chapter5: C Preprocessor.

1.1.1.3 DECLARE STATEMENT

The DECLARE STATEMENT statement can now be used to declare identifiers for SQL statements or stored procedure blocks. For detailed information, please refer to Chapter11: Dynamic SQL Statements.

1.1.1.4 Using DO <function name> in WHENEVER statement

With version 5.3.3 it became possible to use the DO clause in the WHENEVER statement to call a desired function in response to the occurrence of an error. For detailed information, please refer to Chapter8: Handling Runtime Errors.

1.1.1.5 New Command-Line Options

- `-D`

  This option is used to specify a macro name so that it will be recognized when it is present in code.

- `-keyword`

  This option is used to output a list of all reserved words.

- `-parse`

  This option is used to define a range to be parsed by the precompiler.

- `-I`

  This option is used to specify an include path.

- `-debug`

  This option is used for debugging, and outputs information about host variables and the names of macros.

For detailed information about all available command-line options, please refer to Chapter2: The C/C++ Precompiler.

1.1.2 Changes to Functionality

1.1.2.1 Elimination of the SES_DECLARE Macro

The requirement to use #ifdef SES_DECLARE to determine whether the SES_DECLARE macro has been defined in a header file in order to declare host variables has been lifted. To declare host variables anywhere in source files, set the value of the `-parse` command-line option to "full" or move the host variable declarations to the host variable declaration section.

For detailed information, please refer to Chapter2: The C/C++ Precompiler.

1.1.2.2 Lifted Limitations on Host Variables

Values can now be assigned to host variables in the host variable declaration section.

When using structures as host variables, it is now possible to use `typedef` to define a structure type, and then declare structures based on that type. Additionally, it is possible to access individual array elements of array-type variables in embedded SQL statements.

Pointers can now be used as host variables, not only for the char and structure types, but also for other data types as well. Host variables can be used without the colon (":") in the INTO clause of a SELECT statement. Additionally, `union` type variables can also be used as host variables.

In SESC, in order to use the value of a function parameter in an embedded SQL statement, it was necessary to either copy the values of function parameters into local host variables, or to declare global host variables to store the values to be used in embedded SQL statements. This inconvenience has now been eliminated, making development more convenient and improving performance.

For detailed information, please refer to Chapter4: Host Variable Declaration Section and Chapter6: Host Variable Data Types.

1.1.2.3 Changes to Data Type Names

The names of the SES_CLOB, SES_BLOB, SES_BINARY, SES_BYTES, and SES_NIBBLE data types have been changed to APRE_CLOB, APRE_BLOB, APRE_BINARY, APRE_BYTES, and APRE_NIBBLE, respectively. Of course, backward compatibility has been assured, meaning that it's also safe to use the old names.

1.1.2.4 New Names for the Executable and Library Files

The name of the precompiler executable file has been changed from sesc to apre, and the name of the libsesc.a file has been changed to libapre.a. However, there is no need to modify existing makefile code, because copies of the apre executable and the libapre.a library, named sesc and libsesc.a respectively, have been provided in the package.

2 The C/C++ Precompiler

2.1 Introduction and Concepts

2.1.1 Introduction

APRE (the ALTIBASE HDB C/C++ Precompiler) is a programming tool that accepts source code containing embedded SQL as input, translates the embedded SQL statements into standard runtime library calls, and generates a modified source program that can be compiled in the host language and executed.

APRE makes it easy for users to write and precompile applications that contain embedded SQL statements.

By embedding SQL statements into applications, users can create applications that have all of the functionality that is available when creating a program using the ODBC API, and can do so much more easily.

2.1.2 Precompiler Environment Settings

The following environment settings are required in order to compile and link a file that is output by APRE:

2.1.2.1 Required Header File

The ulpLibInterface.h header file is necessary. It is located in the $ALTIBASE_HOME/include directory. That is, in order to compile an application that was precompiled with APRE, it will be necessary to use the following option in your C/C++ compiler:

```
-I $ALTIBASE_HOME/include
```

2.1.2.2 Required Library Files

The library files libapre.a and libodbccli.a (or apre.lib and odbccli.lib in Windows) are also necessary. They are located in the $ALTIBASE_HOME/lib directory.

In order to link a compiled application program with these libraries, it is necessary to use all of the following options:

```
–L $ALTIBASE_HOME/lib –lapre –lodbccli -lalticore -lpthread
```

2.1.3 Handling SIGPIPE

In the event that network access is interrupted for whatever reason, receipt of the SIGPIPE signal via a software pipeline can forcibly terminate a running application. This requires the SIGPIPE signal to be handled within the application.

However, the client library of ALTIBASE HDB is unable to process incoming pipeline signals. Additionally, if the functions in the client library of ALTIBASE HDB are called while a SIGPIPE signal is being processed, the application might become nonresponsive.

It is thus necessary to handle the SIGPIPE signal within the application without calling the functions

in the client library of ALTIBASE HDB. Once the SIGPIPE signal has been handled, the client library functions of ALTIBASE HDB can be called as usual.

2.1.4 The Precompilation Process

APRE is used to precompile a program that was written in C or C++ and includes embedded SQL statements. It outputs a C or C++ program in which the embedded SQL has been converted into a form that is understandable by the C or C++ compiler. The input file is a text file containing C or C++ source code, and must have the .sc extension. The file output by APRE can have either the `.c` or `.cpp` extension. The user can choose the desired filename extension using the `-t` command-line argument. If this is omitted, the default extension is `.c`.

2.1.4.1 Executing the Precompile Command

```
apre [ apre-options ] filename
```

2.1.4.2 APRE Command-Line Options

filename: This is a text file that contains C or C++ source code, including embedded SQL statements. The filename extension must be .sc. It is possible to specify more than one file, in which case all of them will be preprocessed individually. When specifying multiple files, the asterisk ("*") wildcard character is useful.

[Example 1] Precompile a program that was written in C. The precompilation operation creates the *sample1.c* file.

```
$ apre sample1.sc
```

[Example 2] Precompile multiple programs that were written in C. Note the use of the asterisk ("*") wildcard character in the second example.

```
$ apre sample1.sc sample2.sc
$ apre *.sc
```

<apre-options>: APRE*C/C++ command-line options are specified here, before the name of the file(s) to precompile. For details, please refer to the next section, Command-Line Options.

2.1.4.3 Precompile Messages

The screen that is displayed when APRE is executed is shown below.

```
$ apre sample1.sc
-------------------------------------------------------
 Altibase C/C++ Precompiler.
 Release Version 6.1.1.1
 Copyright 2009, ALTIBase Corporation or its subsidiaries.
 All rights reserved.
----------------------------------------------------------------
```

2.2 Command-Line Options

The following command-line options can be used when precompiling applications. This section explains each of the command-line options in detail.

2.2.1 -h

When this option is used, the precompile operation is not performed, and APRE help information is displayed. The following screen will be shown:

```
% apre -h
=====================================================================
APRE (Altibase Precompiler) C/C++ Precompiler HELP Screen
=====================================================================
Usage  :  apre [<options>] <filename>

-h                : Display this help information.
-t <c|cpp>        : Specify the file extension for the output file.
                    c   - File extension is '.c' (default)
                    cpp - File extension is '.cpp'
-o <output_path> : Specify the directory path for the output file.
                    (default : current directory)
-mt               : When precompiling a multithreaded application,
                    this option must be specified.
-I<include_path> : Specify the directory paths for files included using APRE
C/C++.
                    (default : current directory)
-parse <none|partial|full>
                  : Control which non-SQL code is parsed.
-D<define_name>   : Use to define a preprocessor symbol.
-v                : Output the version of APRE.
-n                : Specify when CHAR variables are not null-padded.
-unsafe_null      : Specify to suppress errors when NULL values are fetched
                    and indicator variables are not used.
-align            : Specify when using alignment in AIX.
-spill <values>   : Specify the register allocation spill area size.
-keyword          : Display all reserved keywords.
-debug <macro|symbol>
                  : Use for debugging.
                    macro   - Display macro table.
                    symbol  - Display symbol table.
-nchar_var <variable_name_list>
                  : Process the specified variables using
                    the Altibase national character set.
-nchar_utf16      : Set client nchar encoding to UTF-16.

======================================================================
```

2.2.2 -t {c|cpp}

This is used to choose the filename extension of the file created as a result of the APRE precompiling operation. When this option is set to “c”, the filename extension will be “.c”, whereas when this option is set to “cpp”, the filename extension will be “.cpp”. If neither extension is specified, the filename extension will be “.c”.

2.2.2.1 Example

Use the `-t` option to precompile a program written in C++. After APRE has executed the command, a file named "sample1.cpp" will be created.

```
$ apre -t cpp sample1.sc
```

2.2.3 -o *output_path*

This is used to specify the location of the file(s) created by APRE. If this option is omitted, the resultant file(s) will be created in the current directory. Only one path can be specified. That is, when precompiling and creating multiple files, the resultant files must all be created in the same directory.

2.2.3.1 Example

Use the `-o` option to specify the location of the file generated by APRE. The resultant file, *sample1.c*, will be created in the `./src` directory.

```
$ apre -o ./src sample1.sc
```

2.2.4 -mt

If the file to be precompiled is a multi-threaded program, this option must be specified. If the program to be compiled consists of more than one file, this option must be used when precompiling all of the files for the application, so care must be taken when not precompiling all of the files for an application at the same time.

This option has the same function as the following embedded SQL statement:

```
EXEC SQL OPTION(THREADS=TRUE);
```

That is, it is not necessary to use both the `-mt` command-line option and the above SQL statement in the file to be precompiled: one or the other may be safely omitted.

When precompiling multiple files belonging to the same application at one time, the use of this option is preferable to the use of the embedded SQL statement shown above, because this option applies to all of the files being precompiled at the same time.

For more information about the use of the OPTION statement, please refer to Chapter7: Embedded SQL Statements.

2.2.4.1 Example

Use the `-mt` option to precompile a multithreaded program written in C. This command will result in the creation of a file named *sample1.c*.

```
$ apre -mt sample1.sc
```

2.2.5 -I *include_path*

This option is used to specify the location(s) of the header file(s) to be used in the precompiling

operation. Both absolute and relative paths can be specified. APRE will always look for the header file in the current directory first, followed by the directories specified here.

In order to specify multiple locations, the `-I` option can be specified multiple times.

2.2.5.1 Example

Use the `-I` option to specify the location of header files to be used for precompiling. When this option is specified as shown, APRE will look for the header file in the current directory first, and will then look in the */include* directory.

```
$ apre -I. -I/include sample1.sc
```

2.2.6 -parse {none|partial|full}

This option is used to specify the range within the source file(s), which are specified within the source code using the `#include` directive, that is parsed by the precompiler. When this option is not specified, it defaults to `partial`.

2.2.6.1 none

If this option is set to `none`, the precompiler processes only the macro commands and host variable declarations that are found within the EXEC SQL BEGIN/END DECLARE SECTION block, and ignores any macro commands and host variable declarations that are not found within that block. However, all embedded SQL statements found within the source file(s) are processed.

2.2.6.2 partial

If this option is set to `partial`, the precompiler processes all macro commands, but processes only the host variable declarations that are found within the EXEC SQL BEGIN/END DECLARE SECTION block. Additionally, the macro commands that are found in the header files that are included using the #include directive are processed, whereas the host variables found within these files are not. However, as with the `none` option, all embedded SQL statements found within the source file(s) are processed.

2.2.6.3 full

If this option is set to full, the precompiler executes an internal C parser and processes all host variables, regardless of whether they were declared inside or outside the EXEC SQL BEGIN/END DECLARE SECTION block, and all macro commands. Furthermore, not only all macro commands but also all host variables found within the header files included using the #include directive are also processed. Finally, all embedded SQL statements are then precompiled.

2.2.6.4 -parse full and C++ Code

Because APRE's internal C parser is activated when the `-parse` option is set to full, an error will be raised if any C++ source code is encountered during the precompile operation. Therefore, when precompiling C++ source code, either avoid the use of the `-parse` option, or set it to `partial` or `none`.

2.2.6.5 Examples

```
$ apre -parse none –t cpp sample1.sc
$ apre -parse partial –t cpp sample1.sc
$ apre -parse full –t cpp sample1.sc
```

2.2.7 -D{define_name}

This option is used to specify the name of a macro during the precompile operation. This command has the same function as using the #define preprocessor directive in your code.

2.2.7.1 Example

Set the command-line option as shown below to define a macro named ALTIBASE when precompiling sample1.sc.

```
$ apre -DALTIBASE –t cpp sample1.sc
```

2.2.8 -v

This displays the version of APRE.

2.2.8.1 Example

Check the version of the APRE C/C++ precompiler:

```
$ apre –v
Altibase Precompiler2(APRE) Ver.1 6.1.1.1 INTEL_LINUX_ubuntu_8.10-32bit-
6.1.1.1-debug-GCC4.3.2 (i686-pc-linux-gnu) Dec 17 2009 11:47:30
```

2.2.9 -n

This option is used to indicate that any host variables of type CHAR are not null-padded. To prevent truncation, the length of a CHAR type input host variable must be the same as or shorter than the length of the column in the database.

2.2.9.1 Example

```
$ apre -n sample1.sc
```

2.2.10 -unsafe_null

This option is used to prevent an error from being raised even when a NULL value is fetched and an indicator variable is not being used. Normally, without the use of preventive logic involving indicator variables, an error occurs if the value of a column on which a SELECT or FETCH operation is performed is NULL.

2.2.10.1 Example

```
$ apre -unsafe_null sample1.sc
```

2.2.11 -spill {values}

This option is specified only when precompiling in an AIX environment. This is the same as using the `#pragma` directive, as shown below:

```
#pragma options spill={values}
```

2.2.11.1 Example

```
$ apre -spill AIX sample1.sc
```

2.2.12 -keyword

When this option is used, the precompile operation is not performed, and `apre` outputs a list of keywords reserved by APRE, to help programmers avoid using them as variable names in C source code.

2.2.12.1 List of Reserved Keywords

```
$ apre -keyword
:: Keywords for C code ::
 ALTIBASE_APRE APRE_BINARY APRE_BIT APRE_BLOB APRE_BLOB_LOCATOR APRE_BYTES
APRE_CLOB APRE_CLOB_LOCATOR APRE_DUPKEY_ERR APRE_INTEGER APRE_NIBBLE
APRE_NUMERIC MAX_CHAR_PTR SESC_DECLARE SESC_INCLUDE SES_BINARY SES_BIT
SES_BLOB SES_BLOB_LOCATOR SES_BYTES SES_CLOB SES_CLOB_LOCATOR SES_DUPKEY_ERR
SES_INTEGER SES_NIBBLE SES_NUMERIC SQLFailOverCallback SQLLEN SQL_DATE_STRUCT
SQL_TIMESTAMP_STRUCT SQL_TIME_STRUCT VARCHAR

:: Keywords for Embedded SQL statement ::
 ABSOLUTE ADD AFTER AGER ALL ALLOCATE ALTER AND ANY ARCHIVE ARCHIVELOG AS ASC
ASENSITIVE AT AUTOCOMMIT BACKUP BATCH BEFORE BEGIN BETWEEN BLOB_FILE BREAK BY
CASCADE CASE CAST CLEAR_RECPTRS CLOB_FILE CLOSE COALESCE COLUMN COMMIT COM-
PILE CONNECT CONSTANT CONSTRAINT CONSTRAINTS CONTINUE CREATE CUBE CURSOR
CYCLE DATABASE DEALLOCATE DECLARE DEFAULT DELETE DEQUEUE DESC DESCRIPTOR
DIRECTORY DISABLE DISABLE_RECPTR DISCONNECT DISTINCT DO DROP EACH ELSE ELSEIF
ELSIF ENABLE ENABLEALL_RECPTRS ENABLE_RECPTR END ENQUEUE ESCAPE EXCEPTION
EXEC EXECUTE EXISTS EXIT EXTENTSIZE FALSE FETCH FIFO FIRST FIXED FLUSH FOR
FOREIGN FOUND FREE FROM FULL FUNCTION GOTO GRANT GROUP GROUPING HAVING HOLD
IDENTIFIED IF IMMEDIATE IN INDEX INDICATOR INNER INSENSITIVE INSERT INTERSECT
INTO IS ISOLATION JOIN KEY LAST LEFT LESS LEVEL LIFO LIKE LIMIT LOB LOCAL LOCK
LOGANCHOR LOOP MAXROWS MERGE MINUS MODE MOVE MOVEMENT NEW NEXT NOARCHIVELOG
NOCYCLE NOPARALLEL NOT NULL OF OFF OFFLINE OLD ON ONERR ONLINE ONLY OPEN
OPTION OR ORDER OTHERS OUT OUTER PARALLEL PARTITION PARTITIONS PREPARE PRI-
MARY PRIOR PRIVILEGES PROCEDURE PUBLIC QUEUE RAISE READ REBUILD RECOVER REF-
ERENCES REFERENCING RELATIVE RELEASE RENAME REPLACE REPLICATION RESTRICT
RETURN REVERSE REVOKE RIGHT ROLLBACK ROLLUP ROW ROWCOUNT ROWTYPE SAVEPOINT
SCROLL SELECT SENSITIVE SEQUENCE SESSION SET SETS SOME SPLIT SQLCODE SQLERRM
SQLERROR SQLLEN START STATEMENT STEP STORE SYNONYM TABLE TABLESPACE TEMPORARY
THAN THEN THREADS TO TRIGGER TRUE TRUNCATE TYPE TYPESET UNION UNIQUE UNTIL
UPDATE USER USING VALUES VARCHAR VARIABLE VIEW VOLATILE WAIT WAKEUP_RECPTR
WHEN WHENEVER WHERE WHILE WITH WORK WRITE
```

2.2.13 -debug {macro|symbol}

When this option is used, a symbol table containing the names of macros or declared variables in the source code is output. This option is provided for use in debugging source code.

2.2.13.1 macro

If `-debug macro` is specified, a macro list containing the names of all defined macros is output.

2.2.13.2 symbol

If `-debug symbol` is specified, a list of information about declared variables is output.

2.2.13.3 Example

Create the sample1.c file and output a macro list containing the names of all defined macros.

```
$ apre -debug macro sample1.sc
```

Create the sample1.c file and output a list of information about declared variables.

```
$ apre -debug symbol sample1.sc
```

Create the sample1.c file and output both a macro list containing the names of all defined macros and a list of information about declared variables.

```
$ apre -debug macro symbol sample1.sc
```

2.2.14 -nchar_utf16

When this option is used, national character type data are encoded as UTF-16 during the precompile operation. If this option is not specified, national character type data are encoded in the format specified using the ALTIBASE_NLS_USE property.

Note that if the default encoding method is used, the character set specified in the ALTIBASE_NLS_USE property might not be able to express all of the Unicode values stored in the database, and thus data loss may occur when querying data.

2.2.14.1 Example

```
$ apre -nchar_utf16 -t cpp sample.sc
```

2.2.15 -nchar_var {variable_name_list}

When this option is used, APRE processes the specified variables using the national character set of ALTIBASE HDB. Blanks between variable names are not allowed. Additionally, variables within structures cannot be specified.

2.2.15.1 Examples

Specify that the variables *var1* and *var2* in sample1.sc are to be handled as national character type data.

```
$ apre -nchar_var var1,var2 sample1.sc
```

2.3 Programming using Embedded SQL Statements

In this section, a brief explanation of the general flow of applications containing embedded SQL statements is provided, as well as a description of how to approach writing such applications.

Generally, the order in which an application is authored should mirror the general flow of execution of the application, which is as follows:

- Declaring Host Variables
- Connecting to a Database Server
- Executing Embedded SQL Statements
- Handling Runtime Errors
- Disconnecting from the Database Server

2.3.1 Declaring Host Variables

When writing a program, it is first necessary to declare the host variables and indicator variables that will be used. Host variables must be declared in the host variable declaration section if the -partial precompiler option is not set to "full".

For more information about host variables and indicator variables, please refer to Chapter3: Host Variables and Indicator Variables.

2.3.1.1 Considerations when Declaring Host Variables

- Nested structures cannot be used as host variables. In other words, a structure cannot be an element of another structure.
- When declaring array-type host variables, macros can be used only to specify the number of array elements. Macro definitions cannot be used, for example, to specify the location at which the value of a host variable is to be substituted in an embedded SQL statement.
- When declaring a character-type (i.e. char or varchar) output host variable, the length of the host variable must be defined so that it is at least one byte longer than the size of the corresponding column. Otherwise, when a SELECT or FETCH statement is executed, the value in the column will be truncated. In this case, the value returned in sqlca.sqlcode will be SQL_SUCCESS_WITH_INFO.

2.3.1.2 Special Considerations when Declaring Array-Type Host Variables

For complete information about using arrays with embedded SQL statements, please refer to Chapter10: Using Arrays in Embedded SQL Statements.

- Array-type host variables can only be one-dimensional arrays. The exception is that two-dimensional `char` and `varchar` type arrays are allowed.
- An indicator variable cannot be used with a host variable that is an array of structures.

- When an array of structures is used as an output host variable in the INTO clause of a SELECT or FETCH statement, only one output host variable can be used. In other words, the array of structures cannot be used with other output host variables. Therefore, if the output host variable to be used in the INTO clause is an array of structures, the number of elements in the structure must be the same as the number of columns in the select list.

- When an array of structures is used as an insert host variable in the VALUES clause of an INSERT statement, only one input host variable can be used. In other words, the array of structures cannot be used with other input host variables. Therefore, if the input host variable to be used in the VALUES clause is an array of structures, the number of elements in the structure must be the same as the number of columns in the INSERT statement.

- Internally, the `varchar` type is handled as a kind of structure, so it is subject to the above limitations.

- Array-type host variables must not be used together with non-array type host variables in INSERT, UPDATE or DELETE statements.

- If an array-type output host variable is used when a SELECT or FETCH statement is executed, and the number of returned records is smaller than the array size, the value of sqlca.sqlcode will be SQL_SUCCESS.

- Array-type input host variables cannot be used with SELECT statements or cursor-related statements.

- The FOR clause can be used with array-type input host variables to execute an embedded INSERT, UPDATE, or DELETE statement.

- When working with array-type host variables in AUTOCOMMIT mode, a “transaction” is not the totality of operations performed using the entire array. Rather, the operations corresponding to each element are individual transactions, and thus they are committed separately from one another.

- Arrays of pointers cannot be declared or used as host variables.

2.3.1.3 Considerations When Declaring Indicator Variables

- The data type of indicator variables must be `int`.

- When using the `varchar` type as an input host variable without a separately defined indicator variable, it is necessary to specify the value of `len`, which is one of the elements of the `varchar` structure. If the value of the `varchar` array is not NULL, set the value of `len` to the length of the `arr` element. If the `varchar` array is NULL, set `len` to -1.

- For numeric type host variables, indicator variable values other than -1 are meaningless.

- Indicator variables must be used when working with binary type host variables.

2.3.1.4 Host Variable Declaration Section

For complete information about the host variable declaration section, please refer to Chapter4: Host Variable Declaration Section.

- Definitions of data types (typedef) to be used as host variable data types must be made in the

host variable declaration section.

2.3.1.5 Example

The following is an example of a host variable declaration section:

```
< Sample Program: insert.sc >
/* declare host variables */
EXEC SQL BEGIN DECLARE SECTION;
char usr[10];
char pwd[10];
char s_gno[10+1];
char s_gname[20+1];
char s_goods_location[9+1];
int s_stock;
double s_price;
EXEC SQL END DECLARE SECTION;
```

2.3.2 Connecting to a Database Server

After the host variables have been declared, it is necessary to connect to a database server before any SQL statements can be executed.

After a connection with a database server has been successfully established, it will then be possible to execute all embedded SQL statements.

For detailed instructions on how to connect to database servers, please refer to Chapter7: Embedded SQL Statements.

2.3.2.1 About Connections, Multiple Connections, and Sessions

- To establish a new connection using the same name as an existing connection, it is first necessary to execute the FREE or DISCONNECT statement to terminate the existing connection. If the database server is online, execute the DISCONNECT statement, whereas if the database server is offline, execute the FREE statement.

- If the connection method (CONNTYPE) is set to 2 or 3 in the connection string in a USING clause, the DSN and PORT_NO options will be ignored even if they are set, and an attempt will be made to connect with the local database server.

- When two sets of connection options are specified and a connection is successfully established using the first set of options, the value returned in `sqlca.sqlcode` is SQL_SUCCESS. If the connection attempt using the first set of options fails, but a connection is then successfully established using the second set of options, the value returned in `sqlca.sqlcode` is SQL_SUCCES_WITH_INFO. If a connection cannot be established using either set of options, the value returned in `sqlca.sqlcode` is SQL_ERROR.

- A maximum of 1024 embedded SQL statements can be executed per connection.

- In a session in which AUTOCOMMIT is set to OFF, if an application is shut down in the state in which uncommitted transactions exist, all transactions that were not committed at the time that the application is shut down will be rolled back. However, if the DISCONNECT statement is executed before the application is shut down, all pending transactions will be committed.

- The AT clause cannot be used in the following kinds of embedded SQL statements:

```
INCLUDE statement: EXEC SQL INCLUDE …
OPTION Statement: EXEC SQL OPTION …
WHENEVER statement: EXEC SQL WHENEVER …
```

2.3.2.2 Example

The following example shows how to connect to a database server:

```
< Sample Program: connect1.sc >
/* declare host variables */
EXEC SQL BEGIN DECLARE SECTION;
char usr[10];
char pwd[10];
EXEC SQL END DECLARE SECTION;
/* set username */
strcpy(usr, "SYS");
/* set password */
strcpy(pwd, "MANAGER");
EXEC SQL CONNECT :usr IDENTIFIED BY :pwd;
if (sqlca.sqlcode == SQL_SUCCESS) /* check sqlca.sqlcode */
{
   printf("Successfully connected to ALTIBASE server\n\n");
}
else
{
   printf("Error : [%d] %s\n\n", SQLCODE, sqlca.sqlerrm.sqlerrmc);
   exit(1);
}
```

2.3.3 Executing Embedded SQL Statements

After a connection with a database server has been successfully established, it is possible to execute embedded SQL statements. The term “embedded SQL statements” encompasses DML statements such as the SELECT and INSERT statements, DDL statements such as object creation statements, system control statements, cursor-related SQL statements, dynamic SQL statements, and all other SQL statements of ALTIBASE HDB. For more information about using each of the various kinds of embedded SQL statements, please refer to Chapters 7, 9, 10, 11, and 12.

2.3.3.1 Examples

What follows are examples of the use of various kinds of embedded SQL statements.

UPDATE Embedded SQL Example

The following is an example of an UPDATE statement:

< Sample Program: update.sc >

```
/* declare host variables */
EXEC SQL BEGIN DECLARE SECTION;
int s_eno;
short s_dno;
varchar s_emp_job[15+1];
EXEC SQL END DECLARE SECTION;

s_eno = 2;
s_dno = 1001;
```

```
strcpy(s_emp_job.arr, "ENGINEER");
s_emp_job.len = strlen(s_emp_job.arr);

EXEC SQL UPDATE EMPLOYEES
  SET DNO = :s_dno,
    EMP_JOB = :s_emp_job
  WHERE ENO = :s_eno;
```

Cursor Control Embedded SQL Example

The following is an example of the use of cursor control statements:

< Sample Program: hostvar.h >

```
EXEC SQL BEGIN DECLARE SECTION;
typedef struct department
{
  short dno;
  char dname[30+1];
  char dep_location[9+1];
  int mgr_no;
} department;
typedef struct dept_ind
{
  int dno;
  int dname;
  int dep_location;
  int mgr_no;
} dept_ind;
EXEC SQL END DECLARE SECTION;
```

< Sample Program: cursor1.sc >

```
/* specify path to header file */
EXEC SQL OPTION (INCLUDE=./include);
/* include header file for precompiling */
EXEC SQL INCLUDE hostvar.h;

/* declare host variables */
EXEC SQL BEGIN DECLARE SECTION;
/* structure host variables */
department s_department;
/* structure indicator variables */
dept_ind s_dept_ind;
EXEC SQL END DECLARE SECTION;

/* declare cursor */
EXEC SQL DECLARE DEPT_CUR CURSOR FOR
  SELECT *
  FROM DEPARTMENTS;

/* open cursor */
EXEC SQL OPEN DEPT_CUR;

/* fetch cursor in loop */
while(1)
{
  /* use indicator variables to check for NULL values */
  EXEC SQL FETCH DEPT_CUR INTO :s_department :s_dept_ind;
  if (sqlca.sqlcode == SQL_SUCCESS) /* check sqlca.sqlcode */
  {
    printf("%d %s %s %d\n",
    s_department.dno, s_department.dname,
```

```
        s_department.dep_location,
        s_department.mgr_no);
    }
    else if (sqlca.sqlcode == SQL_NO_DATA)
    {
        break;
    }
    else
    {
        printf("Error : [%d] %s\n", SQLCODE, sqlca.sqlerrm.sqlerrmc);
        break;
    }
}
/* close cursor */
EXEC SQL CLOSE DEPT_CUR;
```

2.3.4 Handling Runtime Errors

After every embedded SQL statement has been executed, it is necessary to check the result of execution. The result of execution of embedded SQL statements is stored in the variable sqlca.sqlcode, and, depending on the value of sqlca.sqlcode, the variables SQLSTATE, SQLCODE, etc. can be checked to obtain more information about the result of execution.

For detailed information about all of the variables that can be checked to determine the result of execution of an embedded SQL statement, please refer to Chapter8: Handling Runtime Errors.

2.3.4.1 Considerations when Handling Runtime Errors

The following are some considerations to keep in mind when using SQLCA, SQLCODE, SQLSTATE and WHENEVER to handle run-time errors.

- Every time an embedded SQL statement is executed, be sure to check the value of sqlca.sqlcode so that any errors that occurred will be processed appropriately.
- When a SELECT statement is executed, if the size of an output host variable is smaller than the size of the corresponding character-type column, the data will be truncated so that they can be saved in the host variable. When this happens, the value of `sqlca.sqlcode` will be SQL_SUCCESS_WITH_INFO.
- If no records are affected by an UPDATE or DELETE operation, the value of sqlca.sqlcode will be SQL_NO_DATA. To determine the number of records that were affected by an UPDATE or DELETE operation, check the value of sqlca.sqlerrd[2]. If no records were affected, this value will be 0.
- The SQLCODE error code values are negative decimal integers. However, the error codes in the Error Message Reference are positive hexadecimal values. Therefore, when referring to the Error Message Reference, convert the absolute values of SQLCODE error codes into hexadecimal values.
- The scope of applicability of a WHENEVER statement is not the same as the overall program flow. In particular, a WHENEVER statement applies only to the file in which it is found.
- The WHENEVER statement must precede any embedded SQL statements to which it is intended to apply.
- WHENEVER statements are connection-independent. In other words, a WHENEVER statement

in an application with more than one connection affects all embedded SQL statements within its scope of applicability, regardless of the connection to which the embedded SQL statements pertain.

2.3.4.2 Example

In this example, the variables in the `sqlca` structure are checked to determine the result of execution of an embedded SQL statement.

```
< Sample Program: delete.sc >
/* declare host variables */
EXEC SQL BEGIN DECLARE SECTION;
int s_eno;
short s_dno;
EXEC SQL END DECLARE SECTION;

s_eno = 5;
s_dno = 1000;

EXEC SQL DELETE FROM EMPLOYEES
  WHERE ENO > :s_eno AND
    DNO > :s_dno AND
    EMP_JOB LIKE 'P%';

/* check sqlca.sqlcode */
if (sqlca.sqlcode == SQL_SUCCESS)
{
  /* sqlca.sqlerrd[2] holds the rows-processed(deleted) count */
  printf("%d rows deleted\n\n", sqlca.sqlerrd[2]);
}
else
{
  printf("Error : [%d] %s\n\n", SQLCODE, sqlca.sqlerrm.sqlerrmc);
}
```

2.3.5 Disconnecting from the Database Server

After all embedded SQL statements have been executed, it will be necessary to disconnect from the database server before shutting down the application. Disconnecting from the database server frees all resources that were allocated for the connection. After disconnecting from the database server, it is of course impossible to execute any more embedded SQL statements.

For detailed information about how to connect to and disconnect from database servers, please refer to Chapter7: Embedded SQL Statements.

2.3.5.1 Example

The following example shows how to disconnect from a database server:

```
< Sample Program: connect1.sc >
EXEC SQL DISCONNECT;
```

2.3.6 The Precompile Operation

This is how to execute the precompiling operation using the APRE precompiler:

```
$ apre [<apre - option>] <filename>
```

2.3.6.1 Example

In the following example, the connect1.sc file is precompiled:

```
$ apre connect1.sc
```

3 Host Variables and Indicator Variables

3.1 Host Variables

3.1.1 Overview

Host variables are responsible for data exchange between an application written in a host language and a database server. In other words, host variables store data that have been read from table columns, data that are to be inserted into table columns, etc.

3.1.2 Declaring Host Variables

Host variables are declared as follows:

- Host variables must be declared in the host variable declaration section or the function parameter declaration section.

  If an attempt is made to use a variable in an embedded SQL statement, and the variable was not first declared in either the host variable declaration section or the function argument declaration section, an error saying "The host variable [variable_name] is unknown." will be raised during the precompile operation.

  For more information about the host variable declaration section and the function argument declaration section, please refer to Chapter4: Host Variable Declaration Section.

- The syntax for declaring host variables is as follows:

  ```
  datatype variable_name;
  ```

  This is the same as when declaring variables in a C or C++ program.

  For detailed information about the data types that host variables can have, please refer to Chapter6: Host Variable Data Types.

- Host variables can also be declared as arrays. For the CHAR and VARCHAR types, it is possible to declare one- or two-dimensional arrays, whereas for the other types, it is only possible to declare one-dimensional arrays. For more information about using arrays with embedded SQL statements, please refer to Chapter10: Using Arrays in Embedded SQL Statements.

- APRE can use the CHAR and VARCHAR type host variables to process text data in any of the national character sets supported by ALTIBASE HDB. When handling data in the national character set, use the reserved word shown below:

  ```
  character set [is] nchar_cs
  ```

  Note that if the `-nchar_var` command-line option is used when precompiling the source code, it is not necessary to use the reserved word shown above.

- The names of host variables must start with an alphabetic character (a ~ z, A ~ Z) or the underscore character ("_"), and must not be longer than 50 bytes.

3.1.3 Using Host Variables in Embedded SQL Statements

A host variable can be used anywhere in an embedded SQL statement where the use of a scalar

expression would be allowed.

Host variables must be distinguished from the other elements in embedded SQL statements. This is accomplished by prepending the colon (":") character to the names of host variables whenever they appear in embedded SQL statements.

3.1.4 Example

In the following example, the host variables *s_dno*, *s_dname*, and *s_dep_location* are declared:

```
< Sample Program: select.sc >
EXEC SQL BEGIN DECLARE SECTION;
  short s_dno;
  char s_dname[30+1];
  char s_dep_location[9+1];
EXEC SQL END DECLARE SECTION;

EXEC SQL SELECT DNAME, DEP_LOCATION
  INTO :s_dname, :s_dep_location
  FROM DEPARTMENTS
  WHERE DNO = :s_dno;
```

3.2 Classifying Host Variables

Host variables are classified as either input host variables or output host variables depending on whether they are used to input data into a database server or extract data from a database server.

3.2.1 Output Host Variables

An output host variable is used in an INTO clause of a SELECT or FETCH statement to store query results. An output host variable thus plays the same role as a variable used in the ODBC SQLBindCol() function.

3.2.1.1 Example

The following is an example of the use of output host variables.

In this example, *s_dname* and *s_dep_location* are host variables. The values in the DNAME and DEP_LOCATION columns for the records that satisfy the condition in the WHERE clause are stored in the host variables *s_dname* and *s_dep_location*, respectively.

```
< Sample Program: select.sc >
EXEC SQL BEGIN DECLARE SECTION;
  short s_dno;
  char s_dname[30+1];
  char s_dep_location[9+1];
EXEC SQL END DECLARE SECTION;

s_dno = 1001;
EXEC SQL SELECT DNAME, DEP_LOCATION
  INTO :s_dname, :s_dep_location
  FROM DEPARTMENTS
  WHERE DNO = :s_dno;
```

3.2.2 Input Host Variables

Input host variables are used wherever output host variables are not used. Their primary role is to specify data to be used in SQL statements. For example, an input host variable can be used in the WHERE clause of a SELECT statement to specify a value that is part of a condition, or in the VALUES clause of an INSERT statement to specify a value to be inserted into a particular column of a record.

An input variable can be used anywhere in an embedded SQL statement where the use of a scalar expression would be allowed. Note however that in order to use a host variable in the select list or the GROUP BY or ORDER BY clause of a SELECT statement, its type must be specified using the CAST operator in the SQL statement.

An input host variable can be used in a WHERE clause. However, be aware that when using a host variable in a join predicate in a WHERE clause, the query optimizer will be unaware of its data type, and thus can only use the NL join method when creating an execution plan. To overcome this limitation and allow the optimizer to choose a more efficient joining method, use the CAST operator in the SQL statement to let the optimizer know the type of the host variable.

3.2.2.1 Examples

The following examples illustrate the use of input host variables in various ways.

[Example 1] The following example shows the use of the input host variables *s_gno*, *s_gname*, *s_goods_location*, *s_stock*, and *s_price* in an INSERT statement. The values stored in the input host variables are inserted into respective table columns.

```
< Sample Program: insert.sc >
EXEC SQL BEGIN DECLARE SECTION;
  char s_gno[10+1];
  char s_gname[20+1];
  char s_goods_location[9+1];
  int s_stock;
  double s_price;
EXEC SQL END DECLARE SECTION;

strcpy(s_gno, "F111100002");
strcpy(s_gname, "XX-101");
strcpy(s_goods_location, "FD0003");
s_stock = 5000;
s_price = 9980.21;
EXEC SQL INSERT INTO GOODS
  VALUES (:s_gno, :s_gname, :s_goods_location, :s_stock, :s_price);
```

[Example 2] The following example shows the use of the input host variables *s_dno*, *s_emp_job*, and *s_eno* in an UPDATE statement. The values in the DNO and EMP_JOB columns of the records that satisfy the condition in the WHERE clause are updated with the values of *s_dno* and *s_emp_job*, respectively.

```
< Sample Program: update.sc >
EXEC SQL BEGIN DECLARE SECTION;
  int s_eno;
  short s_dno;
  varchar s_emp_job[15+1];
EXEC SQL END DECLARE SECTION;

s_eno = 2;
s_dno = 1001;
strcpy(s_emp_job.arr, "ENGINEER");
s_emp_job.len = strlen(s_emp_job.arr);
EXEC SQL UPDATE EMPLOYEES
  SET DNO = :s_dno,
    EMP_JOB = :s_emp_job
  WHERE ENO = :s_eno;
```

[Example 3] The following example shows the use of the input host variables s_eno and s_dno in a DELETE statement. The values of the host variables are used in the WHERE clause to determine which records are to be deleted.

```
< Sample Program: delete.sc >
EXEC SQL BEGIN DECLARE SECTION;
  int s_eno;
  short s_dno;
EXEC SQL END DECLARE SECTION;

s_eno = 5;
s_dno = 1000;
EXEC SQL DELETE FROM EMPLOYEES
  WHERE ENO > :s_eno AND
    DNO > :s_dno AND
    EMP_JOB LIKE 'P%';
```

[Example 4] The following example shows the use of the input host variable *s_dno* in a SELECT statement. The value of *s_dno* is used in the WHERE clause to determine which records to retrieve.

```
< Sample Program: select.sc >
EXEC SQL BEGIN DECLARE SECTION;
  short s_dno;
  char s_dname[30+1];
  char s_dep_location[9+1];
EXEC SQL END DECLARE SECTION;

s_dno = 1001;
EXEC SQL SELECT DNAME, DEP_LOCATION
  INTO :s_dname, :s_dep_location
  FROM DEPARTMENTS
  WHERE DNO = :s_dno;
```

[Example 5] IThe following example shows the use of the input host variable *s_call* in the select list of a SELECT statement.

```
< Sample Program: host_target.sc >
EXEC SQL BEGIN DECLARE SECTION;
  double s_call;
EXEC SQL END DECLARE SECTION;

s_call = 0.045;
EXEC SQL SELECT principal sum * ( 1 - CAST( :s_call AS DOUBLE ) ) FROM count;
```

[Example 6] The following example shows the use of the input host variable *s_period* in the GROUP BY clause of a SELECT statement.

```
< Sample Program: host_group.sc >
EXEC SQL BEGIN DECLARE SECTION;
  int s_period;
EXEC SQL END DECLARE SECTION;

s_period = 1; /* 1(month), 3(quarter year), 6(half year) */
EXEC SQL SELECT SUM(sale) FROM sales
  GROUP BY FLOOR( month / CAST( :s_period AS INTEGER ) );
```

[Example 7] The following example shows the use of the input host variable *s_diff* in the join predicate of a WHERE clause.

```
< Sample Program: host_join.sc >
EXEC SQL BEGIN DECLARE SECTION;
  int s_diff;
EXEC SQL END DECLARE SECTION;

s_diff = 1;
EXEC SQL SELECT * FROM t1, t2
  WHERE t1.i1 = t2.i1 + CAST( :s_diff AS INTEGER );
```

3.3 Indicator Variables

3.3.1 Definition

Because NULL table column values cannot be expressed in the host language, a method of handling them separately is required.

To enable APRE to process NULL values, the use of so-called “indicator variables” is supported.

Indicator variables are used alongside host variables in embedded SQL statements to process NULL values.

3.3.2 Why use indicator variables?

3.3.2.1 For Handling NULL Values

Indicator variables can be used to provide information on the basis of which a programmer can judge whether or not a column value is NULL.

If an input indicator variable is set to -1 (SQL_NULL_DATA), the corresponding host variable will be processed as NULL. If the value of an output indicator variable is -1 (SQL_NULL_DATA), it means that the value returned for the corresponding column is NULL.

For example, an indicator variable can be used to indicate whether the value of a host variable to be used in an INSERT statement is NULL, or whether a column value returned by a SELECT statement is NULL.

3.3.2.2 For Managing the Length of Data

Indicator variables can also be used to specify the length of an input value or store the length of a column value returned by a SELECT statement.

Indicator variables can be used to manage data length only for character or binary type host variables.

To specify the length of an input value, an input indicator variable would be used, whereas an output indicator variable would be used to store the length of a returned column value.

If a host variable is a character type variable, and the value to be input or the returned column value is terminated with a null terminator (“\0”) and is known not to be NULL, there is no need to use an indicator variable.

When dealing with a binary type host variable, it is essential to use an indicator variable, even when the input value or the returned column value is known not to be NULL. This is because the binary type is not terminated with a NULL character, and the database needs a way of knowing the length of the input value, while the application needs a way of knowing the length of the returned column.) For more information about the use of binary type host variables, please refer to Chapter6: Host Variable Data Types.

3.3.3 Declaring Indicator Variables

Indicator variables are declared as follows:

- Indicator variables are declared in the host variable declaration section or the function argument declaration section.

  If an attempt is made to use an indicator variable in an embedded SQL statement, and the indicator variable was not previously declared in the host variable declaration section or the function argument declaration section, an error saying "The host variable [variable_name] is unknown." will be raised during the precompile operation.

  For more information about the host variable declaration section and the function argument declaration section, please refer to Chapter4: Host Variable Declaration Section.

- The syntax for declaring indicator variables is as follows:

  `datatype indicator_variable_name;`

  The data type of an indicator variable must be `int` or `SQLLEN` (a predefined type in ODBC). It can also be a data structure, as long as it comprises only the `int` and `SQLLEN` types.

- The names of indicator variables must start with an alphabetic character (a ~ z, A ~ Z) or the underscore character ("_"), and must not be longer than 50 bytes.

3.3.4 Syntax

The syntax for using indicator variables within embedded SQL statements is as follows:

`<:host_variable> [INDICATOR] <:indicator_variable>`

The keyword "INDICATOR" can be omitted.

If the host variable is not a structure, the indicator variable must not be a structure either. However, if the host variable is a structure, the indicator variable must be a structure too.

3.3.5 When is it necessary to use indicator variables?

Indicator variables must be used in the following cases:

3.3.5.1 When an input value is NULL

When inputting a NULL value, an indicator variable must be used, and its value must be set to -1 (SQL_NULL_DATA).

3.3.5.2 When querying a column that does not have a NOT NULL constraint

If the value of a selected or fetched column is NULL and an indicator variable is not being used, the result of execution of the embedded SQL statement (sqlca.sqlcode) will be SQL_SUCCESS_WITH_INFO, and a warning message will be returned in the variable `sqlca.sqlerrm.sqlerrmc`.

3.3.5.3 When the type of an input or output host variable is APRE_BINARY, APRE_BLOB or APRE_BYTES

Because binary types are not NULL-terminated, the database needs a way of knowing the length of an input value. Therefore, the length of the input data must be specified using the indicator variable. In the same way, when dealing with output host variables, the length of returned column values must be stored in indicator variables. For more information about the APRE_BINARY, APRE_BLOB and APRE_BYTES data types, please refer to Chapter6: Host Variable Data Types.

3.3.5.4 When using an APRE_NIBBLE type output host variable

An indicator variable must be used when entering a NULL value in a NIBBLE type column or reading a NULL value from a NIBBLE type column. For more information about the use of the APRE_NIBBLE data type, please refer to Chapter6: Host Variable Data Types.

3.3.6 Considerations

- When a host variable is a structure, the corresponding indicator variable must also be a structure. The two structures must have the same number of elements.

```
Example)
EXEC SQL BEGIN DECLARE SECTION;
  struct tag1 { int i1; int i2; } var1;
  struct tag2 { int i1_ind; int i2_ind; } var1_ind1;
  struct tag3 { int i1_ind; int i2_ind; int i3_ind; } var1_ind2;
EXEC SQL END DECLARE SECTION;

EXEC SQL INSERT INTO T1(I1, I2)
  VALUES (:var1 :var1_ind1);  // acceptable
EXEC SQL INSERT INTO T1(I1, I2)
  VALUES (:var1 :var1_ind2);  // unacceptable
```

- An indicator variable cannot be used with a host variable that is an array of structures.

```
Example)
EXEC SQL BEGIN DECLARE SECTION;
  struct tag1 { int i1; int i2; char i3[11]; } var1[10];
  struct tag2 { int i1_ind; int i2_ind; int i3_ind; } var1_ind1[10];
EXEC SQL END DECLARE SECTION;

EXEC SQL INSERT INTO T1(I1, I2, I3)
  VALUES (:var1 :var1_ind1);  // unacceptable
```

- When dealing with a VARCHAR type host variable, if an indicator variable is specified for use with the host variable, it will be used as the indicator variable, whereas if no indicator variable is specified, the `len` variable, which is an element of the VARCHAR type, will automatically be used as the indicator variable. In this case it is acceptable to use the value of `len` as the indicator variable.

```
Example)
EXEC SQL BEGIN DECLARE SECTION;
  varchar var1;
  int var1_ind;
EXEC SQL END DECLARE SECTION;

/* Inserting 'TEST' in column I1 of table T1
when var1.len is used as an indicator variable */
```

```
strcpy(var1.arr, "TEST");
var1.len = strlen(var1.arr);
EXEC SQL INSERT INTO T1(I1)
  VALUES (:var1);

/* Inserting NULL in column I1 of table T1
when var1.len is used as an indicator variable */
var1.len = -1;
EXEC SQL INSERT INTO T1(I1)
  VALUES (:var1);

/* Inserting 'TEST' in column I1 of table T1
when var1_ind is used as an indicator variable */
strcpy(var1.arr, "TEST");
var1_ind = strlen(var1.arr);
EXEC SQL INSERT INTO T1(I1)
  VALUES (:var1 :var1_ind);
```

3.3.7 Examples

In the following example, *s_goods_location_ind* is used as the indicator variable for the *s_goods_location* host variable, and *s_price_ind* is used as the indicator variable for the *s_price* host variable. Because the value of both indicator variables is SQL_NULL_DATA, NULL will be inserted in the corresponding columns, even though the values of the *s_goods_location* and *s_price* host variables are not NULL.

```
< Sample Program: indicator.sc >
/* declare host variables */
EXEC SQL BEGIN DECLARE SECTION;
  char s_gno[10+1];
  char s_gname[20+1];
  char s_goods_location[9+1];
  int s_stock;
  double s_price;

  /* declare indicator variables */
  int s_goods_location_ind;
  int s_price_ind;
EXEC SQL END DECLARE SECTION;

/* set host variables */
strcpy(s_gno, "X111100002");
strcpy(s_gname, "XX-101");
strcpy(s_goods_location, "FD0003");
s_stock = 5000;
s_price = 9980.21;

/* set indicator variables */
s_goods_location_ind = SQL_NULL_DATA;
s_price_ind = SQL_NULL_DATA;

EXEC SQL INSERT INTO GOODS
  VALUES (:s_gno,
    :s_gname,
    :s_goods_location :s_goods_location_ind,
    :s_stock,
    :s_price :s_price_ind);
```

3.4 Classifying Indicator Variables

Indicator variables are classified as either input indicator variables or output indicator variables depending on whether they are used with output host variables or input host variables.

3.4.1 Output Indicator Variables

If the column corresponding to an output host variable does not have a NOT NULL constraint, it is essential that an indicator variable be used for the host variable. The reason for this is that when the value of a selected or fetched column is NULL and an indicator variable is not being used, the result of execution of the embedded SQL statement (`sqlca.sqlcode`) will be SQL_SUCCESS_WITH_INFO and a warning message will be returned in the variable `sqlca.sqlerrm.sqlerrmc`.

If the value of the indicator variable is -1 (SQL_NULL_DATA), this means that NULL will be returned from the column. Therefore, the value of the output host variable is not meaningful (i.e. a garbage value). If the value of the indicator variable is not -1 (SQL_NULL_DATA), this means that the value in the corresponding column is not NULL, and will be saved in the output host variable. For more detailed information about the value of the indicator variable in such cases, please refer to the section 3.5 Meaning of Indicator Variables.

3.4.1.1 Examples

The following is an example of the use of an output indicator variable.

In this example, the variable *s_good_ind* is used as an indicator variable for the variable *s_goods*. Because *s_goods* is a structure, *s_good_ind* must also be declared as a structure. The two structures will have the same number of components. After the SELECT statement is executed, each of the members of *s_good_ind* will be checked to determine if the value is -1.

< Sample Program: hostvar.h >

```
EXEC SQL BEGIN DECLARE SECTION;
typedef struct goods
{
  char gno[10+1];
  char gname[20+1];
  char goods_location[9+1];
  int stock;
  double price;
} goods;
typedef struct good_ind
{
  int gno;
  int gname;
  int goods_location;
  int stock;
  int price;
} good_ind;
EXEC SQL END DECLARE SECTION;
```

< Sample Program: indicator.sc >

```
/* specify path of header file */
EXEC SQL OPTION (INCLUDE=./include);
/* include header file for precompiling */
```

```
EXEC SQL INCLUDE hostvar.h;
EXEC SQL BEGIN DECLARE SECTION;
  goods s_goods;
  good_ind s_good_ind;
EXEC SQL END DECLARE SECTION;

EXEC SQL SELECT *
  INTO :s_goods :s_good_ind
  FROM GOODS
  WHERE GNO = :s_gno;

/* Because the GNO and GNAME columns have the NOT NULL constraint, their
indicator variables do not have to be checked. */
if (sqlca.sqlcode == SQL_SUCCESS)
{
  if (s_good_ind.goods_location == SQL_NULL_DATA)
  {
    strcpy(s_goods.goods_location, "NULL");
  }
  if (s_good_ind.stock == SQL_NULL_DATA)
  {
    s_goods.stock = -1;
  }
  if (s_good_ind.price == SQL_NULL_DATA)
  {
    s_goods.price = -1;
  }
}
```

3.4.2 Input Indicator Variables

To specify NULL as an input value, it is necessary to use an input indicator variable. In such cases, the value of the indicator variable must be set to -1.

When specifying a non-NULL input value, there is no need to use the corresponding indicator variable, but when using the indicator variable, care must be taken to ensure that there is no possibility that a NULL value will be entered. The meaning of the value of the indicator variable differs depending on the type of the input host variable. For more information, please refer to 3.5 Meaning of Indicator Variables.

3.4.2.1 Example

The following is an example of the use of an input indicator variable.

In this example, the variable *s_goods_location_ind* is used as an indicator variable for the variable *s_goods_location*, and the variable *s_price_ind* is used as an indicator variable for the variable *s_price*. The values of *s_goods_location_ind* and *s_price_ind* are set to SQL_NULL_DATA (-1) to insert NULL into the GOODS_LOCATION and PRICE columns, respectively.

```
< Sample Program: indicator.sc >
EXEC SQL BEGIN DECLARE SECTION;
/* declare host variables */
  char s_gno[10+1];
  char s_gname[20+1];
  char s_goods_location[9+1];
  int s_stock;
  double s_price;
/* declare indicator variables */
  int s_goods_location_ind;
```

```
  int s_price_ind;
EXEC SQL END DECLARE SECTION;

/* set host variables */
strcpy(s_gno, "X111100002");
strcpy(s_gname, "XX-101");
strcpy(s_goods_location, "FD0003");
s_stock = 5000;
s_price = 9980.21;

/* set indicator variables */
s_goods_location_ind = SQL_NULL_DATA;
s_price_ind = SQL_NULL_DATA;

EXEC SQL INSERT INTO GOODS
VALUES (:s_gno,
  :s_gname,
  :s_goods_location :s_goods_location_ind,
  :s_stock,
  :s_price :s_price_ind);
```

3.5 Meaning of Indicator Variables

The following table describes the meanings of indicator variable values depending on the type of the host variable and on whether the indicator variable is an input indicator variable or an output indicator variable.

An indicator variable value of -1 always signifies a NULL host variable value. The meaning of indicator variable values other than -1, however, differs depending on the type of the host variable and on whether the indicator variable is an input indicator variable or an output indicator variable. Therefore, it is important to understand the information in the following table, and to refer back to it when using indicator variables.

It is particularly important that the value of input indicator variables be set correctly, because these values are used internally by the precompiler and the database server.

	Value of Input Indicator Variables		Value of Output Indicator Variables	
Host Variable Type	-1	Values other than -1	-1	Values other than -1
Numeric types	Means the input value is NULL	Not internally used. Not meaningful.	Means the returned value is NULL. The actual value of the host variable does not mean anything. (Garbage value)	Contains the size of the host variable (sizeof).
Character types		Used to indicate the length of the input value (strlen). Must be set.		Contains the length of the returned value (strlen).
Date type		Not internally used. Not meaningful.		Contains the size of the host variable (sizeof).
APRE_BINARY		Used to indicate the length, in bytes, of the input value. Must be set.		Contains the length, in bytes, of the returned value.
APRE_BLOB		Used to indicate the length, in bytes, of the input value. Must be set.		Contains the length, in bytes, of the returned value.
APRE_CLOB		Used to indicate the length, in bytes, of the input value. Must be set.		SQL_NO_TOTAL (-4) indicates that the returned value was truncated. Indicator variable values other than -4 are the length, in bytes, of the returned host variable value.

	Value of Input Indicator Variables		Value of Output Indicator Variables	
Host Variable Type	-1	Values other than -1	-1	Values other than -1
APRE_BYTES		Used to indicate the length, in bytes, of the input value. Must be set.		Contains the length, in bytes, of the returned value.
APRE_NIBBLE		Not internally used. Not meaningful.		The length, in bytes, of the returned value is stored.

Indicator variables are usually used for handling NULL values. However, as shown in the above table, input indicator variable values other than -1 can be meaningful, and are checked and used within the system. Therefore, when using an input indicator variable, it is important to set its value accurately, even when the value of the corresponding host variable is not NULL.

When the value of an input indicator variable that corresponds to a CHAR or BINARY type host variable is not -1, the database server will take the value of the indicator variable as the length of the input value, and process the value accordingly.

3.6 Sample Programs

3.6.1 indicator.sc

This example can be found at $ALTIBASE_HOME/sample/APRE/indicator.sc

3.6.2 Result of Execution

```
$ is -f schema/schema.sql
$ make indicator
$ ./indicator
<INDICATOR VARIABLES>
-----------------------------------------------------------
[Scalar Indicator Variables]
-----------------------------------------------------------
Success insert

-----------------------------------------------------------
[Structure Indicator Variables]
-----------------------------------------------------------
GNO GNAME GOODS_LOCATION STOCK PRICE
-----------------------------------------------------------
X111100002 XX-101 NULL 5000 -1.00

-----------------------------------------------------------
 [Scalar Array Indicator Variables]
-----------------------------------------------------------
3 rows updated
3 times update success

-----------------------------------------------------------
 [Arrays In Structure]
-----------------------------------------------------------
3 rows inserted
3 times inserte success

-----------------------------------------------------------
 [Indicator Variable(.len) of VARCHAR With Output Host Variables]
-----------------------------------------------------------
v_address.arr = [Pusan University]
v_address.len = 16

-----------------------------------------------------------
 [Indicator Variable(.len) of VARCHAR With Input Host Variables]
-----------------------------------------------------------
Success update

-----------------------------------------------------------
 [Indicator Variable of DATE Type With Input Host Variables]
-----------------------------------------------------------
Success update

-----------------------------------------------------------
 [Indicator Variable of DATE Type With Output Host Variables]
-----------------------------------------------------------
d_arrival_date2 = NULL
```

4 Host Variable Declaration Section

4.1 Host Variable Declaration Section

The name, type, and length of host variables are critical information during the precompiling operation. Therefore, the host variables to be used must be defined in a form such that the C/C++ precompiler can be aware of them. This is accomplished in the host variable declaration section.

If you set the `-parse` option to `none` or `partial`, the C/C++ precompiler will be made aware only of the host variables that are declared in a host variable declaration section. Setting the `-parse` option to `full`, however, ensures that all host variables are recognized. It is strongly recommended that all host variables to be used in the program be declared in host variable declaration sections.

4.1.1 Syntax

The syntax shown below is supported for the host variable declaration section:

```
EXEC SQL BEGIN DECLARE SECTION;
/* variable_declarations */
EXEC SQL END DECLARE SECTION;
```

The host variable declaration section begins with the EXEC SQL BEGIN DECLARE SECTION statement and ends with the EXEC SQL END DECLARE SECTION statement. Host variables to be used in the program must be declared between these two statements.

A host variable declaration section can be present both in the file (.sc) to be precompiled and in any header files (.h) that are included in the precompile operation. Note however that when including a header file using the `#include` preprocessor directive, a host variable declaration section is not used to declare host variables, and the -parse option is set to full during the precompile operation, whereas a host variable declaration section is used within a header file that is included using EXEC SQL INCLUDE.

The reason for this is that a header file (.h) that is included using the #include preprocessor directive is referred to not only by the file to be precompiled (.sc), but may also be referred to by C (.c) or C++ (.cpp) source files that do not contain any embedded SQL, so errors may be raised during the compile operation.

4.1.2 Scope of Host Variables

Host variables can be global or local in scope, depending on the location of the host variable declaration section. The method of determining the scope of declared variables is similar to that of C/C++. If a global host variable and a local host variable have the same name, the local variable (i.e. the variable having the narrower scope) will take precedence over the global variable (i.e. the variable having the broader scope).

The precompiler is capable of handling 50 levels of overlapping variables.

4.1.2.1 Example

The following example shows how the preprocessor handles multiple variables that have the same name but are declared such that they have different scopes. The locally declared variable *name* (indicated by #2) takes priority over the global variable *name* (indicated by #1) within the *myfunc()* function. Therefore, when reference is made to a variable called *name* within the function (at #3), this is

handled as a reference to the local variable.

```
EXEC SQL BEGIN DECLARE SECTION;
  char name[20];// #1
EXEC SQL END DECLARE SECTION;

int myfunc(void)
{
  EXEC SQL BEGIN DECLARE SECTION;
    char name[20];// #2
  EXEC SQL END DECLARE SECTION;

  EXEC SQL INSERT INTO T1 VALUES (:name);// #3
}
```

4.1.3 Limitations

The host variable declaration section is limited in two ways that developers must keep in mind when authoring software:

- The names of host variables must begin with an alphabet letter (a ~ z, A ~ Z) or the underscore character ("_"), and must not exceed 50 bytes in length.

Indicator variables must also be declared in the host variable declaration section, and are also subject to the above limitations.

4.1.4 Example

The following example shows how to declare various kinds of host variables:

```
EXEC SQL BEGIN DECLARE SECTION; // #1
  int x, y, z; // #2
  char c1[50], c2[100];  // #3
  varchar v1[50];  // #4
  struct tag1
  {
    int x;
    char y[50];
    varchar z[50];
  } st1;  // #5
  struct tag1 st2;  // #6
EXEC SQL END DECLARE SECTION;  // #7
```

#1: Indicates the beginning of the host variable declaration section.

#2: Declares the variables *x*, *y*, and *z* as `int` type host variables.

#3: Declares the variables *c1* and *c2* as `char` type variables that are 50 and 100 bytes long, respectively.

#4: Declares the variable *v1* as a `varchar` type variable 50 bytes long.

#5: Defines a structure type called `tag1`, and declares the variable *st1*, which is of type `tag1`.

#6: Declares the variable *st2*, which is also of type `tag1`.

#7: Indicates the end of the host variable declaration section.

4.2 Data Type Definition

In addition to the data types that are supported for use in embedded SQL statements, it is also possible to use host variables based on user-defined types in embedded SQL statements. Such user-defined types are defined using the `typedef` statement.

4.2.1 Description

Definitions of data types intended for use as host variable data types must be indicated in a way such that the preprocessor can recognize them. The data type definition (i.e. the `typedef` statement) can only be located in the host variable declaration section. Newly defined data types can be used as host variables, just like other data types.

4.2.2 Examples

Various examples of data type definitions are shown below.

[Example 1] The following example shows the use of the `typedef` keyword:

```
EXEC SQL BEGIN DECLARE SECTION;
  typedef unsigned int UINT;
  typedef unsigned char UCHAR;
EXEC SQL END DECLARE SECTION;
```

[Example 2] The following examples illustrate various ways to define data types and structures.

1. This example shows a data type definition that follows the definition of the structure on which it is based:

```
EXEC SQL BEGIN DECLARE SECTION;
struct department
{
  short dno;
  char dname[30+1];
  char dep_location[9+1];
  int mgr_no;
};
typedef struct department department;
EXEC SQL END DECLARE SECTION;
```

2. This example shows how to define a structure and the corresponding data type at the same time:

```
EXEC SQL BEGIN DECLARE SECTION;
typedef struct department
{
  short dno;
  char dname[30+1];
  char dep_location[9+1];
  int mgr_no;
} department;
EXEC SQL END DECLARE SECTION;
```

3. This example shows a data type definition that precedes the definition of the structure on which it is based:

```
EXEC SQL BEGIN DECLARE SECTION;
typedef struct department department;
struct department
{
  short dno;
  char dname[30+1];
  char dep_location[9+1];
  int mgr_no;
};
EXEC SQL END DECLARE SECTION;
```

4.3 Function Argument Declaration Section

When using a function argument as a host variable, it is necessary to have a way to provide information about the function arguments to the C/C++ precompiler. The function argument declaration section plays the role of providing information about function arguments to the C/C++ precompiler.

4.3.1 Syntax

The syntax of the function argument declaration section is as follows:

```
EXEC SQL BEGIN ARGUMENT SECTION;
/* Declare function arguments to be used as host variables */
EXEC SQL END ARGUMENT SECTION;
```

The function argument declaration section begins with the EXEC SQL BEGIN ARGUMENT SECTION statement and ends with the EXEC SQL END ARGUMENT SECTION statement. Function arguments to be used as host variables must be declared between these two statements.

The function arguments that are declared within the function argument declaration section must be exactly the same as the function arguments declared in the function header.

4.3.2 Description

The function argument declaration section can be located only inside functions that are found inside the file to be precompiled (i.e. the file with the .sc extension). Additionally, the limitations (4.1.3 Limitations) that apply to the host variable declaration section also apply to the function argument declaration section.

Using the function argument declaration section eliminates the need to declare global host variables or copy the values of function arguments to local host variables. This makes development more convenient and improves performance.

4.3.3 Sample Program

4.3.3.1 argument.sc

The sample program can be found at $ALTIBASE_HOME/sample/APRE/argument.sc

4.3.3.2 Result of Execution

```
$ is -f schema/schema.sql
$ make argument
$ ./argument
 <ARGUMENT>
```

5 C Preprocessor

5.1 Overview

The purpose of the APRE C/C++ preprocessor is to process C preprocessor directives. The APRE C/C++ preprocessor can handle most directives, including the `#include` directive for specifying source files to include, the `#define` directive for defining macros, and the `#if` directive for conditionally including source code.

5.1.1 How the C Preprocessor Works

The APRE C/C++ preprocessor recognizes most C preprocessor commands, and efficiently performs macro substitutions. It also includes files as required, and includes or excludes source text on the basis of conditions. The APRE C/C++ preprocessor uses the macro values obtained in the preprocessing step to modify the source text, and then generates an output file.

5.1.1.1 Example

The following example illustrates how the APRE C/C++ preprocessor handles preprocessor directives:

```
#include "my_header.h"
...
#if A
char name[10];
#endif
...
```

Assume that the file my_header.h is in the current directory and contains the following directive:

```
#define A 1
```

In the above example, the APRE C/C++ preprocessor first reads *my_header.h* and remembers the definition of the value *A*. Therefore, when it subsequently processes the `#if` condition, it substitutes 1 for *A*. Because the `#if` condition is thus true, the declaration of the *name* array is included in the source file (i.e. the output text). If the `#if` condition had evaluated to false, the *name* array declaration would have been excluded from the source file.

5.2 C Preprocessor Directives

The C preprocessor directives that the APRE*C/C++ preprocessor recognizes are `#define`, `#undef`, `#include`, `#if`, `#ifdef`, `#ifndef`, `#else`, `#elif` and `#endif`.

5.2.1 #define, #undef

`#define` defines the name of a macro to be used by the APRE C/C++ preprocessor, while `#undef` deletes a previously defined macro.

5.2.1.1 Example

```
...
#define A
#define func()
...
#undef A
#undef func
```

In the above example, the APRE C/C++ preprocessor handles the `#define` command and stores the names *A* and *func()* in a symbol table, and then performs the required macro substitutions whenever the names *A* and *func()* subsequently appear. Finally, when the APRE C/C++ preprocessor encounters the `#undef` command, it deletes the stored names from the symbol table.

5.2.2 #include

This directive instructs the APRE C/C++ preprocessor to read the specified external source file and incorporate any `#define` macros and variables found in the external source file. For more detailed information, please refer to the 5.1.1.1 Example.

The portion of the files referenced using `#include` directives that is actually incorporated in the source text varies depending on how the `-parse` option is set.

5.2.3 #if

When the APRE C/C++ preprocessor encounters the `#if` directive, it evaluates the given condition and uses the result of the evaluation as the basis on which to determine whether to include the source text between the `#if` and `#endif` directives in the precompile operation.

5.2.3.1 Example

```
#define A 1 + 1
#define B A - 2
...
#if B
int var;
#endif
...
#if defined(A)
int var2;
#endif
```

In the above example, the APRE C/C++ preprocessor substitutes *A*-2 for *B*, and then 1+1 for *A*, when evaluating the first `#if` condition. This results in the expression 1+1-2, which evaluates to 0, or false. Therefore, the source text between the first `#if` and `#endif` commands is not included in the output.

The second condition, `#if defined`, is handled in the same way as an `#ifdef` condition.

5.2.4 #ifdef

When the APRE C/C++ preprocessor encounters the `#ifdef` condition, it determines whether to include the source text between the `#ifdef` and `#endif` directives based on whether the name that follows the `#ifdef` keyword is a defined name.

5.2.4.1 Example

```
#define A
#ifdef A
int var;
#endif
...
```

In the above example, the text "int var;" is included in the output of the precompile operation because *A* has been defined.

5.2.5 #ifndef

This condition is the opposite of the `#ifdef` condition. If the `#ifndef` condition evaluates to false, the source text between the `#ifndef` and `#endif` directives is included in the output of the precompile operation, whereas if it evaluates to true, the source text is excluded from the output of the precompile operation.

5.2.5.1 Example

```
#define A
#ifndef A
int var;
#endif
...
```

In this example, the text "int var;" is excluded from the output of the precompile operation because *A* has been defined.

5.2.6 #else

If this directive is provided between an `#if`, `#ifdef` or `#ifndef` condition and the corresponding `#endif` directive, and the condition evaluates to false, then the source text between the `#else` and `#endif` directives will be included in the output of the precompile operation.

5.2.6.1 Example

```
...
```

```
#define A 0
#if A
int var1;
#else
int var2;
#endif
...
```

In the above example, the source text between the `#else` and `#endif` directives will be included in the output of the precompile operation because the `#if` condition evaluates to false.

5.2.7 #elif

If this directive is provided between an `#if`, `#ifdef` or `#ifndef` condition and the corresponding `#endif` directive, and the first condition evaluates to false, then the `#elif` condition is evaluated, and the source text between the `#elif` and `#endif` directives is included in the output of the precompile operation if the `#elif` condition evaluates to true.

5.2.7.1 Example

```
...
#define A 0
#define B 1
#if A
int var1;
#elif B
int var2;
#else
int var3;
#endif
...
```

In the above example, the source text between the `#elif` and `#else` directives is included in the output of the precompile operation, because the `#if` condition is not satisfied and the `#elif` condition is satisfied.

5.2.8 #endif

This indicates the end of a block of text that is included or excluded based on the result of evaluation of an `#if`, `#ifdef` or `#ifndef` condition.

5.3 Limitations on the Use of the Preprocessor

This section covers a few limitations of the APRE C/C++ Preprocessor, including some directives that it ignores.

5.3.1 Ignored Directives

The APRE C/C++ preprocessor ignores some C preprocessor directives, because they are not necessary for the precompile operation. One example is the `#pragma` directive, which does not need to be processed by the precompiler because it is used only by the C compiler.

The commands that are ignored by the APRE C/C++ preprocessor during the precompile operation are as follows:

5.3.1.1

This directive converts a preprocessor macro parameter to a string constant.

5.3.1.2

This directive merges two preprocessor tokens in a macro definition.

5.3.1.3 #error

This directive is used to output a compile-time error message.

5.3.1.4 #pragma

The #pragma directive is used to pass implementation-dependent information to the C compiler.

5.3.1.5 #line

This directive is used to provide line number information to the C compiler.

5.3.2 Limitations on the Use of #define

The use of the `#define` directive with the APRE C/C++ precompiler is limited in one important way: names defined using the `#define` directive cannot be used within embedded SQL statements.

5.3.2.1 Example

```
#define RESEARCH_DEPT 40
...
EXEC SQL SELECT empno, sal
 INTO :emp_number, :salary /* host arrays */
 FROM emp
 WHERE deptno = RESEARCH_DEPT; /* INVALID! */
```

In the above example, the embedded SQL statement would result in an error, because 40 will not be

substituted for RESEARCH_DEPT in the WHERE clause.

5.3.3 Limitations on the Use of #if

When a user-defined macro function is used in an `#if` condition, the condition may not evaluate as expected, so it is recommended that `#if` conditions not contain user-defined macro functions.

5.3.3.1 Example

```
#define fun(X,Y) X-Y
...
#if fun(1,1)
int var;
#else
int var2;
#endif
...
```

5.3.4 Limitations on the Use of #include

The APRE C/C++ Preprocessor raises an error if a header file that is included using the `#include` directive contains embedded SQL statements. Additionally, header files included in this way must not include declarations of VARCHAR type variables. If you need to include a header file that contains embedded SQL statements or VARCHAR declarations, you must use the EXEC SQL INCLUDE statement to include the header file.

When EXEC SQL INCLUDE is used to include a header file, the APRE C/C++ Preprocessor includes the entire contents of the header file in the output source file (i.e. the resultant output file with the .c or .cpp filename extension.). Therefore, it is acceptable for header files included in this way to contain embedded SQL statements and VARCHAR declarations. In contrast, when the `#include` directive is used to include a header file, APRE only processes the header file's macro commands and C variable declarations.

5.4 Example

The following simple example illustrates how the `#define` and `#ifdef` directives can be used to conditionally input data into a database. Because a macro called ALTIBASE is defined, the host variable *s_goods_alti* is declared. If it were not defined, the host variable *s_goods_ora* would be declared.

```
< Sample Program: macro.sc > /
*********************************************************
 * SAMPLE : MACRO
 * 1. Using #define, #if, #ifdef
 *********************************************************/

/* specify path of header file */
EXEC SQL OPTION (INCLUDE=./include);
/* include header file for precompiling */
EXEC SQL INCLUDE hostvar.h;

/* define ALTIBASE */
#define ALTIBASE

int main()
{
  /* declare host variables */
  char usr[10];
  char pwd[10];
  char conn_opt[1024];

  /* structure type */
#ifdef ALTIBASE
  goods s_goods_alti;
#else
  goods s_goods_ora;
#endif

  int i;
  printf("<INSERT>\n");

  /* set username */
  strcpy(usr, "SYS");
  /* set password */
  strcpy(pwd, "MANAGER");
  /* set various options */
  strcpy(conn_opt, "DSN=127.0.0.1;CONNTYPE=1"); /* PORT_NO=20300 */

  /* connect to altibase server */
  EXEC SQL CONNECT :usr IDENTIFIED BY :pwd USING :conn_opt;
  /* check sqlca.sqlcode */
  if (sqlca.sqlcode != SQL_SUCCESS)
  {
    printf("Error : [%d] %s\n\n", SQLCODE, sqlca.sqlerrm.sqlerrmc);
    exit(1);
  }

  /* use structure host variables */
#ifdef ALTIBASE
  strcpy(s_goods_alti.gno, "F111100010");
  strcpy(s_goods_alti.gname, "ALTIBASE");
  strcpy(s_goods_alti.goods_location, "AD0010");
  s_goods_alti.stock = 9999;
  s_goods_alti.price = 99999.99;
#else
  strcpy(s_goods_ora.gno, "F111100011");
```

```
  strcpy(s_goods_ora.gname, "ORACLE");
  strcpy(s_goods_ora.goods_location, "AD0011");
  s_goods_ora.stock = 0001;
  s_goods_ora.price = 00000.01;
#endif

  /* conditional insertion using #ifdef. */
  EXEC SQL INSERT INTO GOODS VALUES (
#ifdef ALTIBASE
    :s_goods_alti
#else
    :s_goods_ora
#endif
  );

  printf("------------------------------------------------------------\n");
  printf("[Structure Host Variables] \n");
  printf("------------------------------------------------------------\n");
  /* check sqlca.sqlcode */
  if (sqlca.sqlcode == SQL_SUCCESS)
  {
    /* sqlca.sqlerrd[2] holds the rows-processed(inserted) count */
    printf("%d rows inserted\n\n", sqlca.sqlerrd[2]);
  }
  else
  {
    printf("Error : [%d] %s\n\n", SQLCODE, sqlca.sqlerrm.sqlerrmc);
  }

  /* disconnect */
  EXEC SQL DISCONNECT;

  /* check sqlca.sqlcode */
  if(sqlca.sqlcode != SQL_SUCCESS)
  {
    printf("Error : [%d] %s\n\n", SQLCODE, sqlca.sqlerrm.sqlerrmc);
  }
}
```

5.5 The ALTIBASE_APRE Macro

The APRE C/C++ preprocessor contains a predefined macro called ALTIBASE_APRE, which is used when determining whether to precompile certain portions of source code. The ALTIBASE_APRE macro is particularly useful when preprocessing source code that contains large and unnecessary header files that are not necessary for the precompile operation.

The following example illustrates the use of the ALTIBASE_APRE macro to avoid precompiling the header.h file.

5.5.1 Example

```
#ifndef ALTIBASE_APRE
#include <header.h>
#endif
```

In the above example, the *header.h* file will not be read while the APRE C/C++ preprocessor precompiles the source code, because the ALTIBASE_APRE macro is defined within APRE, and thus APRE evaluates the `#ifndef` condition as false. However, the ALTIBASE_APRE macro is not defined within a separate C or C++ compiler, and thus the compiler will evaluate the `#ifndef` condition as true, and include the *header.h* file in the compile operation.

The ALTIBASE_APRE macro is intended for use with the `#ifdef` and `#ifndef` preprocessor directives.

5.6 Considerations

This section explains some considerations to keep in mind when using the APRE C/C++ Preprocessor.

5.6.1 Defining Macros

If a macro is defined using a command-line option when executing the C compiler, then in most cases the same macro must also be defined using the `-D` command-line option when using the APRE C/C++ precompiler. For example, if a C compiler is executed from the command line as shown below:

```
$ cc -DDEBUG ...
```

Then the *DEBUG* macro should also be defined when executing the APRE C/C++ precompiler, before executing the C compiler. This is shown below.

```
$ apre -DDEBUG ...
```

5.6 Considerations

6 Host Variable Data Types

6.1 Overview

Host variables differ from variables in C or C++ applications in how they are used, in their functionality, and in how they are declared. It follows that host variable data types are different from C data types.

The following data types can be used as host variables:

- Most fundamental C and C++ data types. The fundamental C/C++ types that can be used for host variables are described in detail later in this chapter (6.2 Fundamental C/C++ Data Types).
- The extended data types provided by the APRE environment for use in embedded SQL statements. These are described in detail later in this chapter (6.3 Extended APRE Data Types).
- User-defined data types declared in the host variable declaration section

This chapter ends with a discussion of the issues related to performing type conversion between host variable types and the data types that are used in an Altibase database.

6.2 Fundamental C/C++ Data Types

Most of the fundamental data types supported for use as C and C++ data types can also be used for host variables. The fundamental C/C++ types that can be used for host variables are set forth below.

6.2.1 Numeric Types

The following numeric types can be used as host variable data types:

6.2.1.1 Integer Types

```
int, short int, long int, short, long, long long, unsigned int, unsigned
short int, unsigned long int, unsigned short, unsigned long, unsigned long
long
```

6.2.1.2 Real Number Types

```
float, double
```

6.2.1.3 Unavailable Numeric Type

The `long double` type is not supported for use as a host variable data type.

6.2.2 Character Types

The following character types can be used as host variable data types:

6.2.2.1 Character Type

```
char, unsigned char
```

6.2.2.2 Precautions

An output host variable corresponding to a CHAR type database column must be declared so that its length is one (1) byte longer than the length of the database column. The reason for this is that the length of the data stored in a CHAR type column is fixed, so the length of the data that are returned will always be the same as the length of the column, and the host variable requires one additional byte to store the NULL terminating character at the end.

If a host variable is not declared so that it is at least one byte longer than the database column to which it corresponds, then when a SELECT or FETCH statement is executed, the value returned in the sqlca.sqlcode variable will be SQL_SUCCESS_WITH_INFO rather than SQL_SUCCESS.

When declaring a host variable for use with a database column, it is common to declare and use a single “input/output” host variable, that is, a host variable that is used as both an input and output variable for the column, rather than declaring separate input and output host variables. Therefore, for the above reason pertaining to output host variables, when declaring an input/output variable of this type for use with a CHAR type database column, it must be declared such that its length is one byte greater than the length of the column.

6.2.3 Pointer Types

All host variable types that are available in APRE can be used as base types for pointers.

When using a pointer to an array as an input variable in an INSERT statement, set the number of array elements using the FOR clause. For more information about the FOR clause, please refer to Chapter10: Using Arrays in Embedded SQL Statements.

6.2.3.1 char*

A Pointer to a character string can be used as a host variable.

The `char*` type is convenient for use when using a function argument as a host variable. For more information about using a function argument as a host variable, please refer to Chapter4: Host Variable Declaration Section.

6.2.3.2 MAX_CHAR_PTR

When using a pointer to a character string as a host variable, the precompiler assumes that the maximum size of the string to which the host variable points is 65000 bytes, which is predefined in the internally provided MAX_CHAR_PTR macro. This is because the precompiler cannot know the actual allocated size. Therefore, when a smaller amount of memory than the value of the MAX_CHAR_PTR macro is allocated to a char* type output host variable, care must be taken because a character string that is longer than the allocated memory size and smaller than the value of the MAX_CHAR_PTR macro can be stored in the host variable. In this case, memory corruption will occur.

It may become necessary to declare a pointer to a string that is more than 65000 bytes long. In such cases, before declaring the char* type host variable, use the MAX_CHAR_PTR macro to redefine the maximum size of a string to which a char* type host variable can point.

Redefine the MAX_CHAR_PTR macro as follows:

```
#define MAX_CHAR_PTR 90000
```

After the MAX_CHAR_PTR macro has been redefined, it becomes possible to allocate an amount of memory equal to the value of the MAX_CHAR_PTR macro, and to declare a char* type host variable that points to a string that occupies this much memory.

The MAX_CHAR_PTR macro does not need to be defined within the host variable declaration section.

6.2.3.3 Structure Pointers

A pointer to a structure can be used as a host variable data type. A pointer to a structure is convenient to use when using a function argument as a host variable. For more information about using a function argument as a host variable, please refer to Chapter4: Host Variable Declaration Section.

After a pointer to a structure has been declared, be sure to allocate an appropriate amount of space in memory. This is critical, because the precompiler has no way of checking whether or not enough space for the structure has been allocated.

6.2.3.4 Pointer to Array

When using a pointer to a 1-dimensional array in the VALUES clause of an INSERT statement, specify the number of array elements using the FOR clause.

Note however that when using a pointer to a 1-dimensional array in the VALUES clause of an INSERT statement with the FOR clause, the following data types cannot be used. Additionally, it is impossible to use a pointer to a 2-dimensional array of the following data types in an INSERT statement. Both cases will lead to unexpected results.

```
char, varchar, APRE_BINARY, APRE_BYTES, APRE_NIBBLE, APRE_NUMERIC, APRE_BLOB,
APRE_CLOB, APRE_BIT
```

To use a pointer to an array of integer values as an input host variable in an INSERT statement, use the FOR clause, as shown in the following example:

```
int sInt[10];
int *sIntptr;

sIntptr = sInt;

EXEC SQL FOR 10 INSERT INTO T2 VALUES ( :sIntptr );
```

For more information about the use of the FOR clause, please refer to Chapter10: Using Arrays in Embedded SQL Statements.

6.2.3.5 Examples

[Example 1] This example demonstrates the use of the *v_ename* `char*` type input host variable.

```
< Sample Program: argument.sc >
void ins_employee(int v_eno, char* v_ename, short v_dno)
{
EXEC SQL BEGIN ARGUMENT SECTION;
  int v_eno;
  char* v_ename;
  short v_dno;
EXEC SQL END ARGUMENT SECTION;

  EXEC SQL INSERT INTO TODAY_EMPLOYEE
    VALUES (:v_eno, :v_ename, :v_dno);
}
```

[Example 2] The following example shows how to define the MAX_CHAR_PTR macro.

```
#define MAX_CHAR_PTR 90000
EXEC SQL BEGIN DECLARE SECTION;
  char* var1;
EXEC SQL END DECLARE SECTION;
// or
EXEC SQL BEGIN DECLARE SECTION;
#define MAX_CHAR_PTR 90000
  char* var1;
EXEC SQL END DECLARE SECTION;
```

[Example 3] This example shows three different ways to define a structure type, declare a structure, and declare a pointer to the structure.

1. Declare a structure and a pointer to the structure in the same statement.

```
struct tag1
{
  int a;
} *A;
A = (struct tag1*)(malloc(sizeof(struct tag1)));
INSERT INTO T1 VALUES ( :A );
// or
INSERT INTO T1 VALUES (:A->a);
```

2. First declare the structure, and then declare a pointer to the structure in a separate statement.

```
struct tag1
{
  int a;
};
struct tag1 *A;
A = (struct tag1*)(malloc(sizeof(struct tag1)));
SELECT I1 INTO :A FROM T1; or SELECT I1 INTO :A->a FROM T1;
```

3. First declare a structure and define a type based on the structure in the same statement, and then declare a pointer to the type in a separate statement.

```
typedef struct tag1
{
  int a;
} tag1Type;
tag1Type *A;
A = (tag1Type*)(malloc(sizeof(tag1Type)));
SELECT I1 INTO :A FROM T1;
// or
SELECT I1 INTO :A->a FROM T1;
```

In the following example, vDataT2 is a pointer to a structure, and is used as an input host variable.

< Sample Program: pointer.sc >

```
EXEC SQL BEGIN DECLARE SECTION;
typedef struct tag
{
  char n1[11];
  int n2;
} tagType;

tagType *dataT2;
EXEC SQL END DECLARE SECTION;

void ins_t2(tagType* vDataT2)
{
  EXEC SQL BEGIN ARGUMENT SECTION;
    tagType *vDataT2;
  EXEC SQL END ARGUMENT SECTION;

  EXEC SQL INSERT INTO T2 VALUES (:vDataT2->n1, :vDataT2->n2);
}
```

6.2.4 Structure Types

6.2.4.1 struct

Structures (`struct`) can be used as host variable data types.

Using the structure type obviates the need to list multiple host variables one by one in an embedded SQL statement when retrieving data from or inserting data into multiple columns in a table. Instead, it is possible to use a single host variable, which makes the development process much more convenient. For example, a structure-type host variable can be used in the VALUES clause of an INSERT statement, or in the INTO clause of a SELECT statement.

Even arrays of structures and structures containing arrays are valid data types for use as host variables. For more information about the use of arrays, please refer to Chapter10: Using Arrays in Embedded SQL Statements.

6.2.4.2 Limitations

- When a host variable is a structure, the corresponding indicator variable must also be a structure, and must have the same number of elements as the host variable.

```
Example) EXEC SQL BEGIN DECLARE SECTION;
  struct tag1 { int i1; int i2; } var1;
  struct tag2 { int i1_ind; int i2_ind; } var1_ind1;
  struct tag3 { int i1_ind; int i2_ind; int i3_ind; } var1_ind2;
EXEC SQL END DECLARE SECTION;

EXEC SQL INSERT INTO T1(I1, I2)
  VALUES (:var1 :var1_ind1);  // acceptable
EXEC SQL INSERT INTO T1(I1, I2)
  VALUES (:var1 :var1_ind2);  // unacceptable
```

- Nested structures cannot be used as host variables. In other words, a structure cannot have another structure as one of its constituent elements.

```
Example)
EXEC SQL BEGIN DECLARE SECTION;
struct tag1
{
  int i1;
  struct tag2
  {
    int i2;
    int i3;
  } sub_var;
} var1;
EXEC SQL END DECLARE SECTION;  // unacceptable
```

- It is impossible to use an indicator variable with a host variable that is an array of structures. This means that it is necessary to guarantee that no NULL column values are returned when using an array of structures as an output host variable. If a NULL column value is returned, the value stored in the sqlca.sqlcode variable will be SQL_SUCCESS_WITH_INFO.

```
Example) EXEC SQL BEGIN DECLARE SECTION;
  struct tag1 {int i1; int i2; char i3[11]; } var1[10];
  struct tag2 {int i1_ind; int i2_ind; int i3_ind; } var1_ind[10];
EXEC SQL END DECLARE SECTION;

EXEC SQL INSERT INTO T1(I1, i2, i3)
VALUES (:var1 :var1_ind);  // unacceptable
```

- When using an array of structures as a host variable in the INTO clause of a SELECT or FETCH statement, only one output host variable can be used. In other words, such an output host variable cannot be used with other host variables. Therefore, when using an array of structures as an output host variable in the INTO clause, the underlying structure will need the same

number of constituent elements as the number of columns in the select list.

Similarly, when using an array of structures as a host variable in the VALUES clause of an INSERT statement, only one input host variable can be used. In other words, such an input host variable cannot be used with other host variables. Therefore, when using an array of structures as an input host variable in the VALUES clause, the underlying structure will need the same number of constituent elements as the number of columns in the INSERT statement.

```
Example)
EXEC SQL BEGIN DECLARE SECTION;
  struct tag1 { int i1; int i2; } var1[10];
  int var2[10];
EXEC SQL END DECLARE SECTION;

EXEC SQL INSERT INTO T1(I1, I2, i3)
  VALUES (:var1, :var2);  // unacceptable
```

- The last two limitations are due to the internal rule that requires all host variables to be included in the structure when the host variable is a structure array.

6.2.4.3 Examples

The following example demonstrates the use of the structure type.

In this example, a structure type called *goods* is defined, and the host variable *s_goods*, which is of the *goods* type, is declared. The *s_goods* variable is then used as an input host variable in an INSERT statement.

< Sample Program: hostvar.h >

```
EXEC SQL BEGIN DECLARE SECTION;
typedef struct goods
{
  char gno[10+1];
  char gname[20+1];
  char goods_location[9+1];
  int stock;
  double price;
} goods;
EXEC SQL END DECLARE SECTION;
```

< Sample Program: insert.sc >

```
/* specify path of header file */
EXEC SQL OPTION (INCLUDE=./include);
/* include header file for precompiling */
EXEC SQL INCLUDE hostvar.h;

EXEC SQL BEGIN DECLARE SECTION;
  goods s_goods;
EXEC SQL END DECLARE SECTION;

strcpy(s_goods.gno, "F111100003");
strcpy(s_goods.gname, "XX-102");
strcpy(s_goods.goods_location, "AD0003");
s_goods.stock = 6000;
s_goods.price = 10200.96;

EXEC SQL INSERT INTO GOODS VALUES (:s_goods);
```

6.3 Extended APRE Data Types

Beyond the fundamental C/C++ data types, APRE provides additional data types for use as host variables and in embedded SQL statements. These extended data types are described below, along with how to use them.

6.3.1 VARCHAR

6.3.1.1 varchar

The `varchar` type may be declared in either lower case or upper case, that is, as either `varchar` or `VARCHAR`. Internally, it is a kind of structure. For example, if a `varchar` type variable is declared as follows:

```
varchar a[10];
```

The underlying structure would appear thus:

```
struct { int len; char arr[10] ;}a;
```

The constituent elements of the varchar type variable can thus be referred to using the period (".") operator in this way:

```
a.arr
```

This is the same as when referring to the constituent elements of any other structure.

The `varchar` type has its own built-in indicator variable. This role is played by the first constituent element, namely `len`. Therefore, when it is necessary to use an indicator variable with a `varchar` type host variable, there is no need to declare a separate indicator variable, thus making the use of the `varchar` type very convenient.

Although the `varchar` type comes with its own indicator variable, it is still possible to declare and use a separate indicator variable. This is useful when the `varchar` type is just one element inside another structure type host variable and a structure type indicator variable is declared for use with the structure type host variable, so that a separate indicator variable corresponding to the varchar type element can be provided inside the structure type indicator variable.

6.3.1.2 Advantage

Because the `varchar` type has its own internal indicator variable, there is no need for the user to specify a separate indicator variable. This makes it convenient to use the `varchar` type when it is necessary to use an indicator variable.

6.3.1.3 Considerations

- Unless a separate indicator variable is specified for use with a `varchar` type host variable, `len`, one of its constituent elements, will function as the indicator variable. Therefore, when using a `varchar` type variable as an input host variable, it is necessary to expressly specify the value of `len` when not using a separate indicator variable. If it is desired to input NULL data, then set the value of `len` to -1. When entering non-NULL data, set the value of `len` to the actual length of the arr element, excluding the trailing NULL character.

```
Example) EXEC SQL BEGIN DECLARE SECTION;
  varchar var1;
EXEC SQL END DECLARE SECTION;

strcpy(var1.arr, "ABC");
var1.len = strlen(var1.arr);

EXEC SQL INSERT INTO T1(I1)
  VALUES (:var1);  // acceptable
```

- When using the `varchar` type as an output host variable that will receive a value from a CHAR type column, be sure to declare the length of the host variable so that it is one (1) byte longer than the size of the corresponding CHAR type column. The reason for this is that the length of the data stored in a CHAR type column is fixed, so the length of the data that are returned will always be the same as the length of the column, and the host variable requires one additional byte to store the NULL terminating character at the end.

  If a host variable is not declared so that it is at least one character longer than the database column to which it corresponds, then when a SELECT or FETCH statement is executed, the value returned in the sqlca.sqlcode variable will be SQL_SUCCESS_WITH_INFO.

- When using a two-dimensional `varchar` array as a host variable in the INTO clause of a SELECT or FETCH statement, only one output host variable can be used. In other words, such an output host variable cannot be used with other output host variables. Therefore, when using a two-dimensional `varchar` array as an output host variable in an INTO clause, the corresponding select list can contain only one column.

  Similarly, when using a two-dimensional `varchar` array as a host variable in the VALUES clause of an INSERT statement, only one input host variable can be used. In other words, such an input host variable cannot be used with other input host variables. Therefore, when using a two-dimensional `varchar` array as an input host variable in the VALUES clause of an INSERT statement, the VALUES clause can contain only one column value.

  The reason for this is that the `varchar` type is a structure, and thus the limitation on the use of structures also applies to the `varchar` type.

```
Example)
EXEC SQL BEGIN DECLARE SECTION;
  varchar var1[10][10+1];
  int var2[10];
EXEC SQL END DECLARE SECTION;

EXEC SQL INSERT INTO T1(I1, I2)
  VALUES (:var1, :var2);  // unacceptable
```

6.3.1.4 Example

The following example shows the use of the `varchar` type.

In this example, both the input host variable and the output host variable are `varchar` type host variables. The variable *s_cus_job* is the input host variable, while the variable *s_address* is the output host variable. The programmer is responsible for checking the length of *s_cus_job.arr* and specifying it in *s_cus_job.len*. Although not shown in the example, after the SELECT statement is executed, it will be necessary to check whether the value of *s_address.len* is -1, which would indicate that a NULL value was returned.

```
< Sample Program: varchar.sc >
EXEC SQL BEGIN DECLARE SECTION;
```

```
  char s_cname[20+1];
  varchar s_cus_job[20+1];
  varchar s_address[60+1];
EXEC SQL END DECLARE SECTION;

strcpy(s_cus_job.arr, "planner");
s_cus_job.len = strlen(s_cus_job.arr);

EXEC SQL SELECT CNAME, ADDRESS INTO :s_cname, :s_address
  FROM CUSTOMERS
  WHERE CNO = BIGINT'7'
    AND CUS_JOB = :s_cus_job;
```

6.3.2 Date Types

APRE date types can be used only with DATE type database columns.

Three date types are provided for use within APRE. The developer can choose the date type that is most appropriate for the task at hand.

6.3.2.1 SQL_DATE_STRUCT

This type comprises year, month, and date elements. Its structure is shown below:

```
typedef struct tagDATE_STRUCT {
  SQLSMALLINT year;
  SQLSMALLINT month;
  SQLSMALLINT day;
} DATE_STRUCT;
```

6.3.2.2 Example

The following example shows the use of the SQL_DATE_STRUCT type.

In this example, *s_date* is used as both an input and output host variable.

```
< Sample Program: date.sc >
EXEC SQL BEGIN DECLARE SECTION;
  SQL_DATE_STRUCT s_date;
  int s_ind;
EXEC SQL END DECLARE SECTION;

EXEC SQL SELECT JOIN_DATE
  INTO :s_date :s_ind
  FROM EMPLOYEES
  WHERE ENO = 3;

s_date.year = 2003;
s_date.month = 5;
s_date.day = 9;

EXEC SQL UPDATE EMPLOYEES
  SET JOIN_DATE = :s_date
  WHERE ENO = 3;
```

6.3.2.3 SQL_TIME_STRUCT

This type comprises hour, minute, and second elements. Its structure is shown below:

```
typedef struct tagTIME_STRUCT {
  SQLSMALLINT hour;
  SQLSMALLINT minute;
  SQLSMALLINT second;
} TIME_STRUCT;
```

6.3.2.4 Example

The following example shows the use of the SQL_TIME_STRUCT type.

In this example, *s_time* is used as both an input and output host variable.

< Sample Program: date.sc >

```
EXEC SQL BEGIN DECLARE SECTION;
  SQL_TIME_STRUCT s_time;
  int s_ind;
EXEC SQL END DECLARE SECTION;

EXEC SQL SELECT JOIN_DATE
  INTO :s_time :s_ind
  FROM EMPLOYEES
  WHERE ENO = 3;

s_time.hour = 12;
s_time.minute = 12;
s_time.second = 12;

EXEC SQL UPDATE EMPLOYEES
  SET JOIN_DATE = :s_time
  WHERE ENO = 4;
```

6.3.2.5 SQL_TIMESTAMP_STRUCT

This type comprises year, month, date, hour, minute, second, and nanosecond elements. Its structure is shown below. The `fraction` element is the element in which the nanoseconds (i.e. billionths of a second) are stored.

```
typedef struct tagTIMESTAMP_STRUCT {
  SQLSMALLINT year;
  SQLSMALLINT month;
  SQLSMALLINT day;
  SQLSMALLINT hour;
  SQLSMALLINT minute;
  SQLSMALLINT second;
  SQLINTEGER fraction;
} TIMESTAMP_STRUCT;
```

6.3.2.6 Example

The following example shows the use of the SQL_TIMESTAMP_STRUCT type.

In this example, *s_timestamp* is used as both an input and output host variable.

```
< Sample Program: date.sc >
```

```
EXEC SQL BEGIN DECLARE SECTION;
  SQL_TIMESTAMP_STRUCT s_timestamp;
  int s_ind;
EXEC SQL END DECLARE SECTION;

EXEC SQL SELECT JOIN_DATE
  INTO :s_timestamp :s_ind
  FROM EMPLOYEES
  WHERE ENO = 3;

s_timestamp.year = 2003;
s_timestamp.month = 5;
s_timestamp.day = 9;
s_timestamp.hour = 4;
s_timestamp.minute = 0;
s_timestamp.second = 15;
s_timestamp.fraction = 100000;

EXEC SQL UPDATE EMPLOYEES
  SET JOIN_DATE = :s_timestamp
  WHERE ENO = 5;
```

6.3.3 Binary Types

Binary type host variables can be used with CLOB, BLOB, BYTE, or NIBBLE type database columns.

The definitions of the binary types that are supported in APRE are as follows:

```
typedef char APRE_CLOB;
typedef char APRE_BLOB;
typedef char APRE_BINARY;
typedef char APRE_BYTES;
typedef char APRE_NIBBLE;
```

Each of these types is described in detail below.

6.3.3.1 APRE_CLOB

This type can be used only with CLOB type database columns. It is essential that an indicator variable be declared and used with this type.

When using the APRE_CLOB type as an input host variable, set the value of the corresponding indicator variable to -1 to indicate that the value of the host variable is NULL. When the value of the host variable is any other value (i.e. a non-NULL value), set the value of the indicator variable to the length of the data saved in the host variable.

When using this type as an output host variable, a value of -1 in the corresponding indicator variable indicates that a NULL value was returned to the host variable, whereas an indicator variable value greater than 0 indicates that a non-NULL value was returned to the host variable, and furthermore indicates the length of the data saved in the host variable. Finally, if the data returned to the host variable was truncated, SQL_NO_TOTAL (-4) is returned in the indicator variable.

6.3.3.2 Example

The following example demonstrates the use of the APRE_CLOB type.

In this example, *ins_clob* is an input host variable, and *ins_clob_ind* is the corresponding input indicator variable. The value of *ins_clob_ind* is set to the length of the value stored in *ins_clob*.

Meanwhile, *sel_clob* is an output host variable, and *sel_clob_ind* is its output indicator variable. After the execution of the SELECT statement, a *sel_clob_ind* value of -1 means that *sel_clob* is NULL, whereas a *sel_clob_ind* value greater than 0 indicates the length of the value stored in *sel_clob*.

< Sample Program: binary.sc >

```
EXEC SQL BEGIN DECLARE SECTION;
  APRE_CLOB ins_clob[10+1];
  APRE_CLOB sel_clob[10+1];
  SQLLEN ins_clob_ind;
  SQLLEN sel_clob_ind;
EXEC SQL END DECLARE SECTION;

memset(ins_clob, 0x41, 10);
ins_clob_ind = 10; /* set length of ins_clob value in indicator variable */

EXEC SQL INSERT INTO T_CLOB
  VALUES (:ins_clob :ins_clob_ind);

EXEC SQL SELECT *
  INTO :sel_clob :sel_clob_ind
  FROM T_CLOB;
```

6.3.3.3 APRE_BLOB

This type can be used only with BLOB type database columns.

It is essential that an indicator variable be declared and used with this type.

When using the APRE_BLOB type as an input host variable, set the value of the corresponding indicator variable to -1 to indicate that the value of the host variable is NULL. When the value of the host variable is any other value (i.e. a non-NULL value), set the value of the indicator variable to the length of the data saved in the host variable.

When using this type as an output host variable, a value of -1 in the corresponding indicator variable indicates that a NULL value was returned to the host variable, whereas an indicator variable value greater than 0 indicates that a non-NULL value was returned to the host variable, and furthermore indicates the length of the data saved in the host variable.

6.3.3.4 Example

The following example demonstrates the use of the APRE_BLOB type.

In this example, *ins_blob* is an input host variable, and *ins_blob_ind* is the corresponding input indicator variable. The value of *ins_blob_ind* is set to the length of the value stored in *ins_blob*.

Meanwhile, *sel_blob* is an output host variable, and *sel_blob_ind* is its output indicator variable. After the execution of the SELECT statement, a *sel_blob_ind* value of -1 means that *sel_blob* is NULL, whereas a *sel_blob_ind* value greater than 0 indicates the length of the value stored in *sel_blob*.

<Sample Program: binary.sc >

```
EXEC SQL BEGIN DECLARE SECTION;
  APRE_BLOB ins_blob[10+1];
```

```
  APRE_BLOB sel_blob[10+1];
  SQLLEN ins_blob_ind;
  SQLLEN sel_blob_ind;
EXEC SQL END DECLARE SECTION;

memset(ins_blob, 0x21, 10);
ins_blob_ind = 10; /* set length of ins_blob value in indicator variable */

EXEC SQL INSERT INTO T_BLOB
  VALUES (:ins_blob :ins_blob_ind);

EXEC SQL SELECT *
  INTO :sel_blob :sel_blob_ind
  FROM T_BLOB;
```

6.3.3.5 APRE_BINARY

This type is identical to the APRE_BLOB type. For more information, please refer to 6.3.3.3 APRE_BLOB.

6.3.3.6 Example

The following example illustrates the use of the APRE_BINARY type.

In this example, *ins_blob* is an input host variable, and *ins_blob_ind* is the corresponding input indicator variable. The value of *ins_blob_ind* is set to the length of the value stored in *ins_blob*.

Meanwhile, *sel_blob* is an output host variable, and *sel_blob_ind* is its output indicator variable. After the execution of the SELECT statement, a *sel_blob_ind* value of -1 means that *sel_blob* is NULL, whereas a *sel_blob_ind* value greater than 0 indicates the length of the value stored in *sel_blob*.

< Sample Program: binary.sc >

```
EXEC SQL BEGIN DECLARE SECTION;
  APRE_BINARY ins_blob[10+1];
  APRE_BINARY sel_blob[10+1];
  int ins_blob_ind;
  int sel_blob_ind;
EXEC SQL END DECLARE SECTION;

memset(ins_blob, 0x21, 10);
ins_blob_ind = 10; /* set length of ins_blob value in indicator variable */

EXEC SQL INSERT INTO T_BLOB
  VALUES (:ins_blob :ins_blob_ind);

EXEC SQL SELECT *
  INTO :sel_blob :sel_blob_ind
  FROM T_BLOB;
```

6.3.3.7 APRE_BYTES

The APRE_BYTES type can be used only with BYTE type database columns. In all other respects, it is identical to the APRE_BLOB type. For more information, please refer to 6.3.3.3 APRE_BLOB.

6.3.3.8 Example

The following example illustrates the use of the APRE_BYTES type.

In this example, *ins_bytes* is an input host variable, and *ins_bytes_ind* is the corresponding input indicator variable. The value of *ins_bytes_ind* is set to the length of the value stored in *ins_bytes*.

Meanwhile, *sel_bytes* is an output host variable, and *sel_bytes_ind* is its output indicator variable. After the execution of the SELECT statement, a *sel_bytes_ind* value of -1 means that *sel_bytes* is NULL, whereas a *sel_bytes_ind* value greater than 0 indicates the length of the value stored in *sel_bytes*.

< Sample Program: binary.sc >

```
EXEC SQL BEGIN DECLARE SECTION;
  APRE_BYTES ins_bytes[5+1];
  APRE_BYTES sel_bytes[5+1];
  int ins_bytes_ind;
  int sel_bytes_ind;
EXEC SQL END DECLARE SECTION;

memset(ins_bytes, 0x21, 5);
ins_bytes_ind = 5; /* set length of ins_bytes value in indicator variable */

EXEC SQL INSERT INTO T_BYTES
  VALUES (:ins_bytes :ins_bytes_ind);

EXEC SQL SELECT *
  INTO :sel_bytes :sel_bytes_ind
  FROM T_BYTES;
```

6.3.3.9 APRE_NIBBLE

The APRE_NIBBLE type can be used only with NIBBLE type database columns.

When using the APRE_NIBBLE type as an input host variable, use an indicator variable to indicate that the value of the host variable is NULL, but use the first byte of the host variable to indicate the length of the host variable when the value of the host value is any other value (i.e. a non-NULL value). Note that the indicator variable will take precedence over the first byte of the host variable. That is, the value of the indicator variable is first checked, and if it is found to be -1, the host variable is handled as having a NULL value. If the value of the indicator variable is anything other than -1, the first byte of the host variable is taken as the length of the input data. Therefore, to input NULL data, the indicator variable must be set to -1, whereas to input other (non-NULL) values, the length of the input data must be specified in the first byte of the host variable.

Because the length of the input data is stored in the first byte, the actual data will be stored starting in the second byte of the host variable. Therefore, the length of the input data, that is, the nibble count, will be counted from the second byte of the host variable. One nibble is 4 bits.

When using the APRE_NIBBLE type as an output host variable, a value of -1 in the corresponding indicator variable indicates that a NULL value was returned to the host variable. An indicator variable value greater than 0 indicates the total length, in bytes, of the data saved in the host variable.

Meanwhile, as mentioned above, the length of the actual output data, in nibbles, (one nibble = 4 bits) is stored in the first byte of the host variable, and the actual data are stored starting in the second byte.

Therefore, when non-NULL data are returned, the data length is indicated by both the indicator vari-

able and the first byte of the host variable. The relationship between the two data length values is as follows:

```
(indicator variable) = ((first byte of host variable + 1)/2 + 1)
```

6.3.3.10 Example

The following example illustrates the use of the APRE_NIBBLE type.

In this example, *ins_nibble* is an input host variable. Because the value to be input is not NULL, the length of the actual data stored in *ins_nibble* is set in the first byte of *ins_nibble*.

Meanwhile, *sel_nibble* is an output host variable, and *sel_nibble_ind* is its output indicator variable. After the execution of the SELECT statement, a *sel_nibble_ind* value of -1 means that *sel_nibble* is NULL, whereas a *sel_nibble_ind* value greater than 0 indicates the total length, in bytes, of the value stored in *sel_nibble*. Additionally, the first byte in *sel_nibble* (i.e. *sel_nibble[0]*) contains the total length, in nibbles, of the actual data, which are stored starting from the second byte of *sel_nibble* (i.e. *sel_nibble[1]*).

< Sample Program: binary.sc >

```
EXEC SQL BEGIN DECLARE SECTION;
  APRE_NIBBLE ins_nibble[5+2];
  APRE_NIBBLE sel_nibble[5+2];
  int sel_nibble_ind;
EXEC SQL END DECLARE SECTION;

memset(ins_nibble+1, 0x21, 5);
ins_nibble[0] = 10; /* set length of ins_nibble value in ins_nibble[0] */

EXEC SQL INSERT INTO T_NIBBLE
  VALUES (:ins_nibble);

EXEC SQL SELECT *
  INTO :sel_nibble :sel_nibble_ind
  FROM T_NIBBLE;
```

6.3.4 Sample Program

6.3.4.1 varchar.sc

This sample program can be found at $ALTIBASE_HOME/sample/APRE/varchar.sc.

6.3.4.2 Result of Execution

```
$ is -f schema/schema.sql
$ make varchar
$ ./varchar
<VARCHAR TYPE>
----------------------------------------------------
[Scalar VARCHAR]
----------------------------------------------------
s_cname = [DKHAN ]
s_address.arr = [YeongdeungpoGu Seoul]
s_address.len = [20]
```

```
---------------------------------------------------
[Array of VARCHAR]
----------------------------------------------------------
CUS_JOB
---------------------------------------------------
ENGINEER
DOCTOR
DESIGNER
ENGINEER
WEBMASTER
WEBPD
PLANNER
PD
DESIGNER
NULL
MANAGER
BANKER
ENGINEER
BANKER
MANAGER
PLANER
NULL
ENGINEER
NULL
WEBMASTER

---------------------------------------------------
[Structure Included VARCHAR]
---------------------------------------------------
Success insert

---------------------------------------------------
[Array of Structure Included VARCHAR]
--------------------------------------------------
3 rows inserted
3 times insert success
```

6.3.4.3 date.sc

This sample program can be found at $ALTIBASE_HOME/sample/APRE/date.sc.

6.3.4.4 Result of Execution

```
$ is -f schema/schema.sql
$ make date
$ ./date
<DATE TYPE>
---------------------------------------------------
[SQL_DATE_STRUCT]
---------------------------------------------------
JOIN_DATE of ENO is 3 : 2000/1/11

---------------------------------------------------
[SQL_TIME_STRUCT]
---------------------------------------------------
JOIN_DATE of ENO is 3 : 0:0:0

---------------------------------------------------
[SQL_TIMESTAMP_STRUCT]
---------------------------------------------------
JOIN_DATE of ENO is 3 : 2000/1/11 0:0:0:0
```

```
-----------------------------------------------------
[SQL_DATE_STRUCT]
-----------------------------------------------------
Success update with SQL_DATE_STRUCT
1 rows updated

-----------------------------------------------------
[SQL_TIME_STRUCT]
-----------------------------------------------------
Success update with SQL_TIME_STRUCT
1 rows updated

-----------------------------------------------------
[SQL_TIMESTAMP_STRUCT]
-----------------------------------------------------
Success update with SQL_TIMESTAMP_STRUCT
1 rows updated

-----------------------------------------------------
[Array of Structure Included Date Type]
-----------------------------------------------------
Success insert
3 rows inserted
3 times insert success
```

6.3.4.5 binary.sc

This sample program can be found at $ALTIBASE_HOME/sample/APRE/binary.sc.

6.3.4.6 Result of Execution

```
$ is -f schema/schema.sql
$ make binary
$ ./binary
<BINARY TYPE>
-----------------------------------------------------
[APRE_CLOB]
-----------------------------------------------------
Success insert with APRE_CLOB
sel_clob = AAAAAAAAAA
sel_clob_ind = 10

-----------------------------------------------------
 [APRE_BLOB]
-----------------------------------------------------
Success insert with APRE_BLOB
sel_blob = !!!!!!!!!!
sel_blob_ind = 10

-----------------------------------------------------
[APRE_BINARY]
-----------------------------------------------------
Success insert with APRE_BINARY
sel_blob = !!!!!!!!!!
sel_blob_ind = 10

-----------------------------------------------------
[APREBYTES]
-----------------------------------------------------
Success insert with APRE_BYTES
sel_bytes = !!!!!
sel_bytes_ind = 5
```

```
----------------------------------------------------
[APRE_NIBBLE]
----------------------------------------------------
Success insert with APRE_NIBBLE
sel_nibble = !!!!!
sel_nibble_ind = 6
sel_nibble[0] = 10
```

6.4 Column and Host Variable Type Conversion

Various host variable types can be used with each database column type. The following tables set forth the type conversions that are possible between host variable types and column types.

The tables also indicate which type conversions are the least expensive from the aspect of consumption of system resources. Naturally, the host variable types that entail the minimum resource consumption when converted are the recommended types when working with the corresponding column type.

6.4.1 Input Host Variables

This table sets forth the input host variable types that can be converted into each database column type.

<table>
<tr><th colspan="2">Column Type</th><th>Host variable types that can be converted into the column type</th><th>Host variable types that incur the minimum conversion expense</th></tr>
<tr><td rowspan="2">Character type</td><td>CHAR</td><td>char, varchar,
short, int, long, long long,
double, float,
SQL_DATE_STRUCT,
SQL_TIME_STRUCT,
SQL_TIMESTAMP_STRUCT,
APRE_BINARY</td><td>char, varchar</td></tr>
<tr><td>VARCHAR</td><td>char, varchar,
short, int, long, long long,
double, float,
SQL_DATE_STRUCT,
SQL_TIME_STRUCT,
SQL_TIMESTAMP_STRUCT,
APRE_BINARY</td><td>char, varchar</td></tr>
<tr><td rowspan="3">Integer type</td><td>SMALLINT</td><td>char, varchar,
short, int, long, long long,
double, float</td><td>short</td></tr>
<tr><td>INTEGER</td><td>char, varchar,
short, int, long, long long,
double, float</td><td>int</td></tr>
<tr><td>BIGINT</td><td>char, varchar,
short, int, long, long long,
double, float</td><td>long, long long</td></tr>
</table>

Column Type		Host variable types that can be converted into the column type	Host variable types that incur the minimum conversion expense
Real number type	NUMERIC NUMBER DECIMAL	char, varchar, short, int, long, long long, double, float	char, long, long long, float, double
	FLOAT	char, varchar, short, int, long, long long, double, float	float
	REAL	char, varchar, short, int, long, long long, double, float	double
	DOUBLE	char, varchar, short, int, long, long long, double, float	double
Date Type	DATE	char, SQL_DATE_STRUCT, SQL_TIME_STRUCT, SQL_TIMESTAMP_STRUCT	char, SQL_DATE_STRUCT, SQL_TIME_STRUCT, SQL_TIMESTAMP_STRUCT
Binary Type	CLOB	APRE_CLOB	APRE_CLOB
	BLOB	APRE_BLOB	APRE_BLOB
	BINARY	APRE_BINARY	APRE_BINARY
	BYTE	APRE_BYTES	APRE_BYTES
	NIBBLE	APRE_NIBFBLE	APRE_NIBBLE

6.4.2 Output Host Variables

This table sets forth the output host variable types into which each database column type can be converted.

Column Type		Host variable types into which the column type can be converted	Host variable types that incur the minimum conversion expense
Character Type	CHAR	char, varchar, APRE_BINARY	char, varchar
	VARCHAR	char, varchar, APRE_BINARY	char, varchar

Column Type		Host variable types into which the column type can be converted	Host variable types that incur the minimum conversion expense
Integer Type	SMALLINT	char, varchar, short, int, long, long long, double, float APRE_BINARY	short
	INTEGER	char, varchar, short, int, long, long long, double, float APRE_BINARY	int
	BIGINT	char, varchar, short, int, long, long long, double, float APRE_BINARY	long, long long
Real Number Type	NUMERIC NUMBER DECIMAL	char, varchar, short, int, long, long long, double, float APRE_BINARY	char, long, long long, float, double
	FLOAT	char, varchar, short, int, long, long long, double, float APRE_BINARY	float
	REAL	char, varchar, short, int, long, long long, double, float APRE_BINARY	double
	DOUBLE	char, varchar, short, int, long, long long, double, float APRE_BINARY	double
Data Type	DATE	char, SQL_DATE_STRUCT, SQL_TIME_STRUCT, SQL_TIMESTAMP_STRUCT, APRE_BINARY	char, SQL_DATE_STRUCT, SQL_TIME_STRUCT, SQL_TIMESTAMP_STRUCT
Binary Type	CLOB	APRE_CLOB	APRE_CLOB
	BLOB	APRE_BLOB	APRE_BLOB
	BINARY	APRE_BINARY	APRE_BINARY
	BYTE	APRE_BYTES,APRE_BINARY	APRE_BYTES
	NIBBLE	APRE_NIBBLE,APRE_BINARY	APRE_NIBBLE

The APRE_BINARY type can be used as an output host variable for all column types. The APRE_BINARY type does not involve any type conversion, because assigning a value to this type

merely invokes the memcpy() function to store the contents that were retrieved from the database in the host variable without change. It is thus necessary to understand how each column type stores data in memory and to be able to interpret the contents of memory in order to use the APRE_BINARY type as a host variable.

Therefore, although the lack of type conversion means that performance will likely improve when the APRE_BINARY type is used as a host variable, the requirement to understand how data are stored in memory complicates development tasks. Therefore, in most cases it is recommended that the APRE_BINARY type be used only with BLOB type columns.

7 Embedded SQL Statements

7.1 Overview

The term “embedded SQL statement” refers to an SQL statement that resides within an application.

7.1.1 Syntax

```
EXEC SQL … ;
```

An embedded SQL statement begins with the words “EXEC SQL” and ends with a semicolon (“;”).

Between the EXEC SQL keyword and the semicolon, various kinds of SQL statements can be used, including DML statements, such as SELECT and UPDATE statements, and DDL statements, such as CREATE and DROP statements.

7.1.1.1 Limitation

The maximum possible length of an SQL statement is 32kB (kilobytes).

7.1.1.2 Example

The following is an example of an embedded SQL statement.

```
< SELECT statement: select.sc >
EXEC SQL BEGIN DECLARE SECTION;
  short s_dno;
  char s_dname[30+1];
  char s_dep_location[9+1];
EXEC SQL END DECLARE SECTION;

EXEC SQL SELECT DNAME, DEP_LOCATION
  INTO :s_dname, :s_dep_location
  FROM DEPARTMENTS
  WHERE DNO = :s_dno;

< INSERT statement : insert.sc >
EXEC SQL BEGIN DECLARE SECTION;
  char s_gno[10+1];
  char s_gname[20+1];
  char s_goods_location[9+1];
  int s_stock;
  double s_price;
EXEC SQL END DECLARE SECTION;

EXEC SQL INSERT INTO GOODS
  VALUES (:s_gno, :s_gname,
  :s_goods_location,
  :s_stock, :s_price);
```

More detailed information about the syntax of each embedded SQL statement will be provided later in this chapter.

7.1.2 Static Versus Dynamic SQL Statements

Embedded SQL statements can be broadly classified as either static SQL statements or dynamic SQL

statements, depending on whether the contents of the SQL statement are determined when the application is written, or at runtime. This chapter describes only static SQL statements. For more information about dynamic SQL statements, please refer to Chapter7: Embedded SQL Statements.

Embedded SQL statements can also classified into the following categories based on how they handle data and the role that they play.

7.1.2.1 Host Variable Declaration Section

These statements are used to delimit a block of code for declaring host variables for use in other embedded SQL statements. For more detailed information, please refer to Chapter4: Host Variable Declaration Section.

7.1.2.2 Function Argument Declaration Section

These statements are used to delimit a block of code for declaring function arguments for use in other embedded SQL statements. For more detailed information, please refer to Chapter4: Host Variable Declaration Section.

7.1.2.3 Connection-Related SQL Statements

These statements are used to connect to and disconnect from a database.

7.1.2.4 Basic Embedded SQL Statements

These statements include DML statements, such as SELECT, UPDATE, INSERT, and DELETE statements, as well as DDL statements, such as CREATE, DROP, and ALTER statements.

7.1.2.5 Cursor Control SQL Statements

These statements are used together with cursors to process data, and include statements for defining cursors, opening cursors, using cursors to retrieve data, and closing cursors. For more detailed information, please refer to Chapter9: Using Cursors.

7.1.2.6 SQL Statements for Controlling Stored Procedures and Functions

These statements are used for handling stored procedures and stored functions, and include statements for creating, recompiling, executing, and deleting stored procedures and functions. For more detailed information, please refer to Chapter12: Using Stored Procedures in C/C++.

7.1.2.7 Other Embedded SQL Statements

This category includes all SQL statements supported in ALTIBASE HDB that do not fall into one of the above categories. These statements include task control statements and DCL statements for controlling the system and individual transactions.

7.1.2.8 OPTION Statements

These statements are used to set various options provided by the APRE C/C++precompiler.

7.2 Database Connection Statements

Connection-related SQL statements are those that are used to manage a connection with a database server, including the CONNECT and DISCONNECT statements.

7.2.1 CONNECT

This statement is used to connect to the database server.

7.2.1.1 Syntax

```
EXEC SQL CONNECT <:user> IDENTIFIED BY <:passwd>
[ USING <:conn_opt1> [ , <:conn_opt2> ] ];
```

7.2.1.2 Arguments

<:user>

This is the name of the user with which to connect to the database server.

<:passwd>

This is the password corresponding to the user with which a connection is established to the database server.

<:conn_opt1>

This is used to specify various options related to the database server connection.

- DSN: This is the IP address of the database server with which to establish a connection.
- CONNTYPE: This is used to specify the protocol with which to communicate with the database server.
  - 1: TCP/IP
  - 2: UNIX DOMAIN
  - 3: IPC
- PORT_NO: This is used to specify the port number via which to communicate with the database server.
- NLS_USE: This is used to set the character set to use during the session.
  - KO16KSC5601: Korean
  - US7ASCII: English
  - MS949
  - BIG5
  - GB231280
  - UTF8
  - SHIFTJIS

  - EUCJP

- BATCH: This is used to specify the batch processing mode for the session.

  - ON: Batch Processing Mode
  - OFF: Non Batch Processing Mode

<:conn_opt2>

This is used to specify the same database server connection options that are specified using `conn_opt1`. If an attempt to connect with a database server using the options specified in `conn_opt1` fails, another connection attempt will automatically be made using the options specified in `conn_opt2`.

7.2.1.3 Description

One application is permitted to establish one or more connections to a database using embedded SQL statements. When multiple connections to a database are established within a single application, there can be only one connection that does not have a connection name. This chapter only describes the connection that does not have a connection name.

For more information about establishing multiple connections within a single application, please refer to Chapter13: Applications with Multiple Database Connections. For more information about multi-threaded applications, please refer to Chapter14: Multithreaded Applications.

Note: If PORT_NO and NLS_USE are not specified in the connection string, then the environment variables shown below must exist, and must have the same values that are set in the corresponding properties in the altibase.properties file.

```
export ALTIBASE_PORT_NO=20300
export ALTIBASE_NLS_USE=US7ASCII
```

7.2.1.4 Specifying Two Sets of Connection Options

When two sets of connection options are specified and an attempt is made to connect to a database, the following three outcomes are possible:

- SQL_SUCCESS: This is returned when a connection is successfully established using the first set of options.

- SQL_SUCCESS_WITH_INFO: This is returned when the connection attempt using the first set of options fails, but a connection is then successfully established using the second set of options. The error message related to the failure of the first connection attempt is stored in sqlca.sqlerrm.sqlerrmc.

- SQL_ERROR: This is returned when both connection attempts fail. The error messages related to the failure of both connection attempts are consecutively stored in sqlca.sqlerrm.sqlerrmc.

7.2.1.5 Considerations

If an attempt to establish a connection is made when a connection already exists, an error message indicating that a connection has already been established will be displayed. Therefore, if it is desired to establish a connection while a connection exists, it is first necessary to execute FREE or DISCONNECT to terminate the existing connection. If the database server is running, the DISCONNECT state-

ment must be executed, whereas if the database server is not running, the FREE statement must be executed.

If the connection method (CONNTYPE) is set to 2 or 3 in the connection string, the DSN and PORT_NO options will be ignored even if they are set, and an attempt will be made to connect with the local database server.

7.2.1.6 Example

Various database server connection examples are shown below.

[Example 1] This example shows how to connect to the database server by specifying only the user name and the user password. In this case, the other information that is necessary in order to establish a connection with the database server will be read from the environment variables.

```
< Sample Program: connect1.sc >
EXEC SQL BEGIN DECLARE SECTION;
  char usr[10];
  char pwd[10];
EXEC SQL END DECLARE SECTION;

strcpy(usr, "SYS");
strcpy(pwd, "MANAGER");

EXEC SQL CONNECT :usr IDENTIFIED BY :pwd;
```

[Example 2] This example shows how to connect to the database server by specifying the connection method in the USING clause. In this case, the connection to the database server will be established using the user name and the user password stored in the *usr* and *pwd* host variables and the connection information stored in the *conn_opt3* host variable. Any information that is necessary in order to establish a connection with the database server but could not be found in the *conn_opt3* host variable will be read from the environment variables.

```
< Sample Program: connect1.sc >
EXEC SQL BEGIN DECLARE SECTION;
  char usr[10];
  char pwd[10];
  char conn_opt3[100];
EXEC SQL END DECLARE SECTION;

strcpy(usr, "SYS");
strcpy(pwd, "MANAGER");
strcpy(conn_opt3, "DSN=192.168.11.12;CONNTYPE=1;PORT_NO=53000");

EXEC SQL CONNECT :usr IDENTIFIED BY :pwd USING :conn_opt3;
```

[Example 3] This example shows how to connect to the database server by specifying two different sets of connection options in the USING clause. In this case, an attempt will be made to connect to the database server using the user name and the user password stored in the *usr* and *pwd* host variables and the connection information stored in the *conn_opt1* host variable. If this attempt fails, another attempt will be made to connect to the database server using the same user name and user password, but this time with the connection information stored in the *conn_opt2* host variable.

```
< Sample Program: connect2.sc >
EXEC SQL BEGIN DECLARE SECTION;
  char usr[10];
  char pwd[10];
  char conn_opt1[100];
  char conn_opt2[100];
```

```
EXEC SQL END DECLARE SECTION;

strcpy(usr, "SYS");
strcpy(pwd, "MANAGER");
strcpy(conn_opt1, "DSN=192.168.11.12;CONNTYPE=1;PORT_NO=53000");
strcpy(conn_opt2, "DSN=192.168.11.22;CONNTYPE=1;PORT_NO=53000");

EXEC SQL CONNECT :usr IDENTIFIED BY :pwd USING :conn_opt1, :conn_opt2;
if (sqlca.sqlcode == SQL_SUCCESS) /* check sqlca.sqlcode */
{
  printf("Successful connection to ALTIBASE server with first options\n\n");
}
else if (sqlca.sqlcode == SQL_SUCCESS_WITH_INFO)
{
  /* failed connection with first options and then successful connection with
second options */
  printf("Successful connection to ALTIBASE server with second options\n");
  printf("First connection error : [%d] %s\n\n", SQLCODE, sqlca.sqlerrm.sql-
errmc);
}
else
{
  printf("Failed to connect to ALTIBASE server with both first and second
options\n");
  printf("Error : [%d]\n", SQLCODE);
  printf("%s\n\n", sqlca.sqlerrm.sqlerrmc);
  exit(1);
}
```

7.2.2 DISCONNECT

This statement is used to disconnect from the database server.

7.2.2.1 Syntax

```
EXEC SQL DISCONNECT;
```

7.2.2.2 Arguments

None

7.2.2.3 Description

This statement disconnects from the database server and releases all resources that were allocated to the connection.

7.2.2.4 Example

The following example shows the use of the DISCONNECT statement.

```
< Sample Program: connect1.sc >
EXEC SQL DISCONNECT;
```

7.2.3 Sample Programs

7.2.3.1 connect1.sc

This sample program can be found at $ALTIBASE_HOME/sample/APRE/connect1.sc.

7.2.3.2 Result of Execution

```
$ is -f schema/schema.sql
$ make connect1
$ connect1
<CONNECT 1>
-----------------------------------------------------
[Connect]
-----------------------------------------------------
Successful connection to altibase server
-----------------------------------------------------
[Disconnect]
-----------------------------------------------------
Successful disconnection from altibase server
```

7.2.3.3 connect2.sc

This sample program can be found at $ALTIBASE_HOME/sample/APRE/connect2.sc.

7.2.3.4 Result of Execution

```
$ is -f schema/schema.sql
$ make connect2
$ connect2
<CONNECT 2>
-----------------------------------------------------
[Connect With Two ConnOpt]
-----------------------------------------------------
Failed to connect to ALTIBASE server with both first and second options
Error : [-327730]
Failed first connection : Client unable to establish connection
Failed second connection : Client unable to establish connection
```

7.3 Using DDL and DML in Embedded SQL Statements

The notional category "basic embedded SQL statements" essentially refers to those embedded SQL statements in which DML statements, such as SELECT, UPDATE, INSERT, and DELETE, and DDL statements, such as CREATE, DROP, and ALTER, are executed.

7.3.1 SELECT

This statement is used to search one or more database tables for records that meet the specified conditions and store the returned data in host variables. The basic syntax is the same as the general SELECT statement supported in ALTIBASE HDB SQL, however, in order to be able to use host variables, an additional INTO clause is needed.

7.3.1.1 Syntax

```
EXEC SQL SELECT [ ALL | DISTINCT ] <select_list>
INTO <host_var_list>
FROM <table_expression> [ WHERE … ];
```

7.3.1.2 Arguments

<select_list>: Please refer to the *SQL Reference*.

<host_var_list>: This is a list of output host variables and output indicator variables

<table_expression>: Please refer to the *SQL Reference*.

7.3.1.3 Description

Unless the host variable is an array, only one record must be returned. If more than one record is returned, the value returned in the sqlca.sqlcode variable will be SQL_ERROR, and the value returned in the sqlca.sqlerrm.sqlerrmc variable will be an error message indicating that too many rows were returned. When it is expected that more than one record is to be returned, it is necessary to use an array or a cursor.

If the host variable is an array, the number of returned records must be the same as or less than the size of the array. If the number of returned records is greater than the array size, the value returned in the sqlca.sqlcode variable will be SQL_ERROR and the value returned in the sqlca.sqlerrm.sqlerrmc variable will be an error message indicating that too many rows were returned. In such cases, it is necessary either to increase the size of the array, or use a cursor.

7.3.1.4 Result

When the host variable is not an array		When the host variable is an array	
Number of returned records	Result of Execution	Number of returned records	Result of Execution
0	SQL_NO_DATA	0	SQL_NO_DATA
1	SQL_SUCCESS	Fewer than the size of the array	SQL_SUCCESS
		The same number as the size of the array	SQL_SUCCESS
More than 1	SQL_ERROR	More than the size of the array	SQL_ERROR

An sqlca.sqlcode value of SQL_NO_DATA means that zero (0) records were returned. In this case, the contents of the host variable will not have any meaning (i.e. will be a garbage value).

7.3.1.5 Limitations

- An input host variable cannot be an array.

```
Example)
EXEC SQL BEGIN DECLARE SECTION;
  int var1;
  int var2[10];
  int var3[10];
EXEC SQL END DECLARE SECTION;

EXEC SQL SELECT * INTO :var1
  FROM T1 WHERE i1 = :var3;   // unacceptable
// or
EXEC SQL SELECT * INTO :var2
  FROM T1 WHERE i1 = :var3;   // unacceptable
```

- If the output host variable in the INTO clause is an array of structures, only one output host variable can be used. For more information, please refer to Chapter6: Host Variable Data Types.
- When the output host variable in an INTO clause is a `varchar` array, it cannot be used with any other output host variables. For more information, please refer to Chapter6: Host Variable Data Types.
- An input indicator variable cannot be used in the LIMIT clause of a SELECT statement; only an input host variable can be used for this purpose. Additionally, the only input host variable data type that is supported for use with the LIMIT clause is `int`.

7.3.1.6 Example

Various SELECT statement examples are shown below.

[Example 1] In the following example, the *departments* table is searched for records whose *DNO* column value matches the value of the *s_dno* host variable, and the values in the *DNAME* and

DEP_LOCATION columns are loaded into the *s_dname* and *s_dep_location* host variables, respectively.

< Sample Program: select.sc >

```
EXEC SQL BEGIN DECLARE SECTION;
  short s_dno;
  char s_dname[30+1];
  char s_dep_location[9+1];
EXEC SQL END DECLARE SECTION;

s_dno = 1001;
EXEC SQL SELECT DNAME, DEP_LOCATION
  INTO :s_dname, :s_dep_location
  FROM DEPARTMENTS
  WHERE DNO = :s_dno;
```

[Example 2] The following example shows the use of a structure type host variable. In this example, the *departments* table is searched for records whose *DNO* column value matches the value of the *s_dno* input host variable, and the column values are stored in the corresponding elements of the *s_department* structure.

< Sample Program: hostvar.h >

```
EXEC SQL BEGIN DECLARE SECTION;
typedef struct department
{
  short dno;
  char dname[30+1];
  char dep_location[9+1];
  int mgr_no;
} department;
EXEC SQL END DECLARE SECTION;
```

< Sample Program: select.sc >

```
/* specify path of header file */
EXEC SQL OPTION (INCLUDE=./include);
/* include header file for precompiling */
EXEC SQL INCLUDE hostvar.h;

EXEC SQL BEGIN DECLARE SECTION;
  short s_dno;
  department s_department;
EXEC SQL END DECLARE SECTION;

s_dno = 1002;
EXEC SQL SELECT *
  INTO :s_department
  FROM DEPARTMENT
  WHERE DNO = :s_dno;
```

For an example in which a SELECT statement is used to retrieve the contents of a BLOB or CLOB database column, which are then stored to a file, please refer to Appendix A.

7.3.2 INSERT

This statement is used to insert new records into a table.

7.3.2.1 Syntax

Please refer to the *SQL Reference*.

7.3.2.2 Arguments

None

7.3.2.3 Description

Host variables and indicator variables can both be used in the VALUES clause.

7.3.2.4 Example

Various INSERT statement examples are shown below.

[Example 1] In the following example, new records are inserted into the *GOODS* table.

< Sample Program: insert.sc >

```
EXEC SQL BEGIN DECLARE SECTION;
  char s_gno[10+1];
  char s_gname[20+1];
  char s_goods_location[9+1];
  int s_stock;
  double s_price;
EXEC SQL END DECLARE SECTION;

strcpy(s_gno, "F111100002");
strcpy(s_gname, "XX-101");
strcpy(s_goods_location, "FD0003");
s_stock = 5000;
s_price = 9980.21;

EXEC SQL INSERT INTO GOODS
  VALUES (:s_gno, :s_gname, :s_goods_location, :s_stock, :s_price);
```

[Example 2] In the following example, a structure-type host variable is used to insert new records into the *GOODS* table.

< Sample Program: hostvar.h >

```
EXEC SQL BEGIN DECLARE SECTION;
typedef struct goods
{
  char gno[10+1];
  char gname[20+1];
  char goods_location[9+1];
  int stock;
  double price;
} goods;
EXEC SQL END DECLARE SECTION;
```

< Sample Program: insert.sc >

```
/* specify path of header file */
EXEC SQL OPTION (INCLUDE=./include);
/* include header file for precompiling */
```

```
EXEC SQL INCLUDE hostvar.h;

EXEC SQL BEGIN DECLARE SECTION;
  goods s_goods;
EXEC SQL END DECLARE SECTION;

strcpy(s_goods.gno, "F111100003");
strcpy(s_goods.gname, "XX-102");
strcpy(s_goods.goods_location, "AD0003");
s_goods.stock = 6000;
s_goods.price = 10200.96;
EXEC SQL INSERT INTO GOODS VALUES (:s_goods);
```

For an example of the use of an INSERT statement to insert data from a file into a BLOB or CLOB column, please refer to Appendix A.

7.3.3 UPDATE

This statement is used to find records that meet specified conditions and change the values in certain columns of those records.

7.3.3.1 Syntax

Please refer to the *SQL Reference*.

7.3.3.2 Arguments

None

7.3.3.3 Description

Both host variables and indicator variables can be used in both the SET and WHERE clauses.

7.3.3.4 Limitations

- Arrays must not be used together with non-array type variables. For example, if the host variable used in the SET clause is an array, the host variable used in the WHERE clause must also be an array.

```
Example)
EXEC SQL BEGIN DECLARE SECTION;
  int var1[10];
  int var2[10];
  int var3;
EXEC SQL END DECLARE SECTION;

EXEC SQL UPDATE T1
  SET I1 = :var1, I2 = :var2
  WHERE I1 = :var3;  // unacceptable
```

7.3.3.5 Example

Various UPDATE statement examples are shown below.

[Example 1] In this example, records for which the value in the ENO column matches the value of the *s_eno* host variable are found, and the values in the DNO and EMP_JOB columns for those records are updated with the values of the *s_dno* and *s_emp_job.arr* host variables, respectively.

< Sample Program: update.sc >

```
EXEC SQL BEGIN DECLARE SECTION;
  int s_eno;
  short s_dno;
  varchar s_emp_job[15+1];
EXEC SQL END DECLARE SECTION;

s_eno = 2;
s_dno = 1001;
strcpy(s_emp_job.arr, "ENGINEER");
s_emp_job.len = strlen(s_emp_job.arr);

EXEC SQL UPDATE EMPLOYEES
  SET DNO = :s_dno,
    EMP_JOB = :s_emp_job
  WHERE ENO = :s_eno;
```

[Example 2] This example illustrates the use of a structure-type host variable in an UPDATE statement. Records for which the value in the ENO column matches the value of the *s_eno* host variable are found, and the values in the DNO, EMP_JOB, and JOIN_DATE columns for those records are updated with the values of *s_employee.s_dno*, *s_employee.s_emp_job.arr*, and SYSDATE, respectively.

< Sample Program: hostvar.h >

```
EXEC SQL BEGIN DECLARE SECTION;
typedef struct employees
{
  int eno;
  char e_lastname[20+1];
  char e_firstname[20+1];
  varchar emp_job[15+1];
  char emp_tel[15+1];
  short dno;
  double salary;
  char sex;
  char birth[6+1];
  char join_date[19+1];
  char status[1+1];
} employees;
EXEC SQL END DECLARE SECTION;
```

< Sample Program: update.sc >

```
/* specify path of header file */
EXEC SQL OPTION (INCLUDE=./include);
/* include header file for precompiling */
EXEC SQL INCLUDE hostvar.h;

EXEC SQL BEGIN DECLARE SECTION;
  employees s_employee;
EXEC SQL END DECLARE SECTION;

s_eno = 20;
s_employee.dno = 2001;
strcpy(s_employee.emp_job.arr, "TESTER");
s_employee.emp_job.len = strlen(s_employee.emp_job.arr);

EXEC SQL UPDATE EMPLOYEES
```

```
  SET DNO = :s_employee.dno,
    EMP_JOB = :s_employee.emp_job,
    JOIN_DATE = SYSDATE
  WHERE ENO = :s_eno;
```

7.3.4 DELETE

This statement is used to delete the records that satisfy the specified conditions from the corresponding table.

7.3.4.1 Syntax

Please refer to the *SQL Reference*.

7.3.4.2 Arguments

None

7.3.4.3 Description

Both host variables and indicator variables can be used in the WHERE clause.

7.3.4.4 Examples

The following example shows how to delete records that satisfy the specified conditions from the *employees* table.

```
< Sample Program: delete.sc >
EXEC SQL BEGIN DECLARE SECTION;
  int s_eno;
  short s_dno;
EXEC SQL END DECLARE SECTION;

s_eno = 5;
s_dno = 1000;

EXEC SQL DELETE FROM EMPLOYEES
  WHERE ENO > :s_eno AND
    DNO > :s_dno AND
    EMP_JOB LIKE 'P%';
```

7.3.5 Sample Programs

7.3.5.1 select.sc

This sample program can be found at $ALTIBASE_HOME/sample/APRE/select.sc.

7.3.5.2 Result of Execution

```
$ is -f schema/schema.sql
$ make select
```

```
$ ./select
<SELECT>
-----------------------------------------------------
[Scalar Host Variables]
-----------------------------------------------------
DNO DNAME DEP_LOCATION
-----------------------------------------------------
1001 RESEARCH DEVELOPMENT DEPT 1 New York
-----------------------------------------------------
[Structure Host Variables]
-----------------------------------------------------
DNO DNAME DEP_LOCATION MGR_NO
-----------------------------------------------------
1002 RESEARCH DEVELOPMENT DEPT 2 Sydney 13
-----------------------------------------------------
[Error Case : Scalar Host Variables]
-----------------------------------------------------
Error : [-331880] Too many rows returned
```

7.3.5.3 insert.sc

This sample program can be found at $ALTIBASE_HOME/sample/APRE/insert.sc.

7.3.5.4 Result of Execution

```
$ is -f schema/schema.sql
$ make insert
$ ./insert
<INSERT>
-----------------------------------------------------
[Scalar Host Variables]
-----------------------------------------------------
1 rows inserted
-----------------------------------------------------
[Structure Host Variables]
-----------------------------------------------------
1 rows inserted
```

7.3.5.5 update.sc

This sample program can be found at $ALTIBASE_HOME/sample/APRE/update.sc.

7.3.5.6 Result of Execution

```
$ is -f schema/schema.sql
$ make update
$ ./update
<UPDATE>
-----------------------------------------------------
[Scalar Host Variables]
-----------------------------------------------------
1 rows updated
-----------------------------------------------------
[Structure Host Variables]
-----------------------------------------------------
1 rows updated
```

7.3.5.7 delete.sc

This sample program can be found at $ALTIBASE_HOME/sample/APRE/delete.sc.

7.3.5.8 Result of Execution

```
$ is -f schema/schema.sql
$ make delete
$ ./delete
<DELETE>
----------------------------------------------------
[Scalar Host Variables]
----------------------------------------------------
7 rows deleted
```

7.4 Using Other Embedded SQL Statements

This category includes task control statements, DCL statements for controlling the system and individual transactions, and the INCLUDE OPTION and THREAD OPTION statements.

7.4.1 AUTOCOMMIT

This statement is used to change the AUTOCOMMIT mode for the current session.

7.4.1.1 Syntax

```
EXEC SQL AUTOCOMMIT { ON | OFF };
```

7.4.1.2 Arguments

None

7.4.1.3 Example

The following examples illustrate how to change the AUTOCOMMIT mode. To change to AUTOCOMMIT mode:

```
EXEC SQL AUTOCOMMIT ON;
```

To change to Non-AUTOCOMMIT mode:

```
EXEC SQL AUTOCOMMIT OFF;
```

7.4.2 COMMIT

7.4.2.1 Syntax

```
EXEC SQL COMMIT;
```

7.4.2.2 Arguments

None

7.4.2.3 Description

This statement is used to indicate that the current transaction was successful and terminate it. The changes effected by the transaction will be stored in the database permanently.

7.4.2.4 Consideration

Note that an error is never raised when this statement is executed, even when the autocommit mode of the current session is AUTOCOMMIT.

7.4.2.5 Example

The following example shows how to use the COMMIT statement in an embedded SQL statement:

```
EXEC SQL COMMIT;
```

7.4.3 SAVEPOINT

7.4.3.1 Syntax

```
EXEC SQL SAVEPOINT <savepoint_name>;
```

7.4.3.2 Arguments

<savepoint_name>: This is the name to be given to the savepoint.

7.4.3.3 Description

A savepoint is a defined point in time at which the changes made by a transaction that has not finished executing are temporarily stored. The SAVEPOINT embedded SQL statement is used to define an explicit savepoint, to which the transaction can be rolled back if necessary.

7.4.3.4 Consideration

Note that an error is never raised when this statement is executed, even when the autocommit mode of the current session is AUTOCOMMIT.

7.4.3.5 Example

The following example shows how to use the SAVEPOINT statement in an embedded SQL statement:

```
EXEC SQL SAVEPOINT sp;
```

7.4.4 ROLLBACK

7.4.4.1 Syntax

```
EXEC SQL ROLLBACK [ TO SAVEPOINT <savepoint_name> ];
```

7.4.4.2 Arguments

<savepoint_name>: This is the name of a savepoint to which to return.

7.4.4.3 Description

This statement is used to restore the database to the state that existed prior to the commencement

of execution of the current transaction, or to the state that existed when a specified savepoint was defined. That is, this statement undoes all or some of the operations that have been performed by the current transaction.

If a previously defined savepoint is specified in this statement, the current transaction will be only partially rolled back. That is, the operations performed since the savepoint was defined will be undone.

7.4.4.4 Consideration

Note that an error is never raised when this statement is executed, even when the autocommit mode of the current session is AUTOCOMMIT.

7.4.4.5 Example

The following example shows how to use the ROLLBACK statement in an embedded SQL statement:

```
EXEC SQL ROLLBACK;
```

or

```
EXEC SQL ROLLBACK TO SAVEPOINT sp;
```

7.4.5 BATCH

This statement is used to change a connection property so as to activate or deactivate batch processing.

7.4.5.1 Syntax

```
EXEC SQL BATCH { ON | OFF };
```

7.4.5.2 Arguments

None

7.4.5.3 Description

When batch processing mode is active, the execution (i.e. transmission to the server) of embedded SQL statements is delayed until the transaction is committed or a SELECT statement is subsequently executed. Batch processing is possible because the result of uncommitted INSERT, UPDATE, and DELETE statements can only be read from within the same transaction.

Batch processing can improve performance in environments in which INSERT, UPDATE, and DELETE statements are frequently executed.

7.4.5.4 Example

The following examples show how to use the BATCH statement in an embedded SQL statement to change the batch mode. To activate batch processing mode:

```
EXEC SQL BATCH ON;
```

To deactivate batch processing mode:

```
EXEC SQL BATCH OFF;
```

7.4.6 FREE

This statement is used to release all resources that were allocated when the connection with the database server was established and embedded SQL statements were executed.

7.4.6.1 Syntax

```
EXEC SQL FREE;
```

7.4.6.2 Arguments

None

7.4.6.3 Description

If the connection with the server is lost while embedded SQL statements are being executed, it is necessary to execute the FREE statement before attempting to re-establish the connection.

The database server must not be running when the FREE statement is executed. If the database server is running, use the DISCONNECT statement instead of the FREE statement.

7.4.6.4 Example

The following example shows the use of the FREE statement:

< Sample Program: free.sc >

```
EXEC SQL FREE;
```

7.4.7 INCLUDE

This statement is used to specify a header file that is to be included in a precompile operation.

7.4.7.1 Syntax

```
EXEC SQL INCLUDE <filename>;
```

7.4.7.2 Arguments

<filename>: This is the name of the header file to be included in the precompile operation.

7.4.7.3 Description

The definitions of host variables and host variable data types are important information that APRE needs to know in order to perform the precompile operation. Therefore, header files that contain host variable type definitions or host variable declarations to be used in the application must be included using the INCLUDE statement if the -parse precompiler option will not be set to “full”.

The EXEC SQL INCLUDE command can be used both in the main source file to be precompiled (i.e. the file with the .sc extension) and in any header files (.h) that are also included using the EXEC SQL INCLUDE command. Note however that this command cannot be used within header files that are included using the #include command.

7.4.7.4 Limitation

Recursive header file inclusions are not allowed. In other words, if *myheader2.h* is included in *myheader1.h*, then *myheader1.h* must not also be included in *myheader2.h*.

```
Example)
<myheader1.h>
EXEC SQL INCLUDE myheader2.h;
...
<myheader2.h>
EXEC SQL INCLUDE myheader1.h; // not allowed
```

7.4.7.5 Example

The following example shows how to use the INSERT statement to specify the header file hostvar.h for inclusion in a precompile operation.

< Sample Program: insert.sc >

```
EXEC SQL INCLUDE hostvar.h;
```

7.4.8 Sample Programs

7.4.8.1 free.sc

This sample program can be found at $ALTIBASE_HOME/sample/APRE/free.sc.

7.4.8.2 Result of Execution

```
$ is -f schema/schema.sql
$ make free
$ ./free
<FREE>
----------------------------------------------------
[Connect]
----------------------------------------------------
Successful connection to altibase server
----------------------------------------------------
[Free]
----------------------------------------------------
Error : [-331796] Function sequence error
----------------------------------------------------
```

```
[Reconnect]
----------------------------------------------------
Error : [-589826] The connection already exists. (Name:default connection)
```

7.5 OPTION Statements

The OPTION statement is used to set various options provided by the ALTIBASE HDB C/C++ precompiler.

7.5.1 INCLUDE

APRE provides various methods of using embedded SQL statements to specify the location of the header files to be included in a precompile operation. One of them is the INCLUDE OPTION statement.

7.5.1.1 Syntax

```
EXEC SQL OPTION (INCLUDE = <pathname>);
```

Arguments

<pathname>: This is the location of the header files to be included in the precompile operation.

Description

This command is used to specify one or more locations in which to look for the header files to be included in the precompile operation. The current directory does not need to be specified.

When specifying multiple locations, they must be separated by commas (","). The INCLUDE OPTION statement must precede all INCLUDE statements.

Example

In the following example, the INCLUDE OPTION statement is used to specify the location in which to look for hostvar.h (namely, the ./include directory), after which the hostvar.h file is included using the INCLUDE statement.

< Sample Program: insert.sc >

```
EXEC SQL OPTION (INCLUDE=./include);
EXEC SQL INCLUDE hostvar.h;
```

7.5.2 THREADS

APRE supports the use of embedded SQL statements in multi-threaded applications. The THREADS OPTION statement provides a basis on which the precompiler can determine whether or not the file to be precompiled is a multi-threaded program.

7.5.2.1 Syntax

```
EXEC SQL OPTION (THREADS = { TRUE | FALSE });
```

7.5.2.2 Arguments

None

7.5.2.3 Description

The THREADS OPTION statement can have either of the following two values:

- TRUE: When the file to be precompiled is a multi-threaded program
- FALSE: When the file to be precompiled is not a multi-threaded program

If the THREADS OPTION statement is not specified, APRE assumes that the file to be precompiled is not a multi-threaded program. Therefore, if the file to be precompiled is a multi-threaded program, then the THREADS OPTION must specified, and must be set to TRUE.

If the `-mt` option is used on the command line when precompiling a multi-threaded program, the THREADS OPTION statement can be omitted.

7.5.2.4 Example

The following example shows how to set the THREADS OPTION to TRUE using the OPTION statement when the file to be precompiled is a multi-threaded program.

```
< Sample Program: mt1.sc >

EXEC SQL OPTION (THREADS=TRUE);
```

8 Handling Runtime Errors

8.1 Overview

Applications must be able to handle internal runtime errors. APRE provides the programmer with numerous methods for handling runtime errors, including variables such as SQLCODE and SQLSTATE and the WHENEVER statement.

8.1.1 Return Values

After an embedded SQL statement is executed, the result of execution is stored in `sqlca.sqlcode`. This variable can have the following values:

- SQL_SUCCESS

  This value indicates that the embedded SQL statement was executed successfully.

- SQL_SUCCESS_WITH_INFO

  This value indicates that the embedded SQL statement was executed but that a warning was detected.

- SQL_NO_DATA

  This value indicates that no records were returned by an executed SELECT or FETCH statement.

- SQL_ERROR

  This value indicates that an error occurred during execution of the embedded SQL statement.

8.2 The sqlca Structure

`sqlca` is an instance of the `ulpSqlca` structure that is declared during the precompile operation. `ulpSqlca` is an internal structure that is used to store the results of execution of an embedded SQL statement, and is defined in the `ulpLibInterface.h` file. Developers can use the `sqlca` variable in their applications to check the result of execution of embedded SQL statements.

8.2.1 ulpSqlca Data Structure Definition

```
typedef struct ulpSqlca
{
  char sqlcaid[8]; /* not used */
  int sqlcabc; /* not used */
  int sqlcode;
  struct
  {
    short sqlerrml;
    char sqlerrmc[2048];
  }sqlerrm;
  char sqlerrp[8]; /* not used */
  int sqlerrd[6];
  char sqlwarn[8]; /* not used */
  char sqlext[8]; /* not used */
} ulpSqlca;
```

8.2.2 sqlca Elements

The `ulpSqlca` structure comprises numerous constituent elements. Some of these elements are reserved for future use, and are thus not described here.

The meaning of each element is as follows:

8.2.2.1 sqlcode

This element is used to store the result of execution of an embedded SQL statement. The value stored herein will be one of the following, which were described above:

- SQL_SUCCESS
- SQL_SUCCESS_WITH_INFO
- SQL_NO_DATA
- SQL_ERROR

8.2.2.2 sqlerrm.sqlerrmc

This element is used to store error messages. The maximum error message length that can be saved herein is 2048 bytes.

8.2.2.3 sqlerrm.sqlerrml

This element is used to store the length of the returned error message.

8.2.2.4 sqlerrd[2]

This element is used to store the number of records that were affected by the execution of an INSERT, UPDATE, or DELETE statement.

When a SELECT or FETCH statement is executed and the output host variable is an array, this element is used to store the number of records that were returned. This is only the number of records that were returned by the most recently executed SELECT or FETCH statement, not a cumulative number of records returned by multiple statements. Therefore, this value will not be larger than the array size.

8.2.2.5 sqlerrd[3]

The value of this variable can be checked after an array-type input host variable is used to execute an embedded SQL statement. This value indicates the number of elements of the array-type host variable for which the operation was successfully performed. Therefore, this value cannot be larger than the array size.

For example, if an array-type input host variable whose size is 3 is used to execute an UPDATE statement, and the respective update operations are successful for the 0th array element, unsuccessful for the 1st array element, and successful for the 2nd array element, a value of 2 will be stored in this variable. Meanwhile, the number of records that were actually updated will be stored in sqlca.sqlerrd[2], which means that a value higher than 2 might be stored in sqlca.sqlerrd[2].

8.2.3 Precautions

- In order to ensure that errors are reliably detected and handled, it is necessary to check sqlca.sqlcode every time an embedded SQL statement is executed.
- When a SELECT statement is used to retrieve a value from a character type column, and the size of the corresponding output variable is smaller than (the size of the column + 1), the character column data will be truncated to the length of the host variable - 1 so that it can be stored therein. At this time, the contents of sqlca.sqlcode will be SQL_SUCCESS_WITH_INFO.
- If no records are affected by an UPDATE or DELETE operation, the contents of sqlca.sqlcode will be SQL_NO_DATA. To check the number of records that were affected by an UPDATE or DELETE operation, check the value of sqlca.sqlerrd[2].

8.3 SQLCODE

If the result of execution of an embedded SQL statement is SQL_ERROR, the error code will be stored in SQLCODE.

8.3.1 Data Structure Definition

```
int SQLCODE;
```

8.3.2 SQLCODE Return Values

- 0: This is returned upon successful execution of an embedded SQL statement. At this time, the value of `sqlca.sqlcode` will be SQL_SUCCESS.
- 1: This is returned when the embedded SQL statement was executed but a warning was detected. At this time, the value of `sqlca.sqlcode` will be SQL_SUCCESS_WITH_INFO.
- 100: This is returned when no records were returned by an executed SELECT or FETCH statement. At this time, the value of `sqlca.sqlcode` will be SQL_NO_DATA.
- -1: This is returned when an error occurred during execution of the embedded SQL statement, but there is no error code corresponding to the error that occurred. At this time, the value of `sqlca.sqlcode` will be SQL_ERROR.
- Other negative values indicate that an error occurred during execution of the embedded SQL statement. In this case, the return value is the actual error code.

8.3.3 Error Codes

Depending on the origin of the error, the error code that is returned when an error occurs during the execution of an embedded SQL statement will be either an APRE error code or a database server error code.

8.3.3.1 Embedded SQL Statement Error Codes

Errors that are raised by embedded SQL statements at runtime will return APRE error codes. These include the following. (For information on errors other than the following, please refer to *Error Message Reference*.)

- -589826: This code is returned when a connection with the same name already exists.
- -589841: This code is returned when the name of the connection exceeds 50 bytes.
- -589857: This code is returned when an attempt is made to execute a SQL statement for handling a cursor, and the name of the cursor has not been declared.
- -589858: This code is returned when an attempt is made to execute a dynamic SQL statement using an identifier for a SQL statement that has not been prepared.

8.3.3.2 Database Server Error Codes

When an error that occurs during the execution of an SQL statement originates in the database server, a database server error code will be returned. For complete information about all ALTIBASE HDB error codes, please refer to the *ALTIBASE HDB Error Message Reference*.

8.3.4 Precaution

The error codes returned by SQLCODE are negative decimal numbers. However, the error codes in the Error Message Reference are positive decimal and hexadecimal numbers. Therefore, when referring to the Error Message Reference, use the absolute value of the error code returned by SQLCODE, or convert this absolute value into a hexadecimal number.

8.4 SQLSTATE

SQLSTATE is used to store a status code. This status code can be used to determine the error that occurred, or the warning that was raised. Checking the value of SQLSTATE is useful when the result of execution of an embedded SQL statement is SQL_ERROR or SQL_SUCCESS_WITH_INFO.

8.4.1 Definition of Data Structure

```
char SQLSTATE[6];
```

8.4.2 Status Codes

- 00000 - This code is returned upon successful execution of an embedded SQL statement.
- 01004 - This code is returned when the size of a character type output host variable is the same as or smaller than the corresponding column size. At this time, the returned data are truncated so that they can be stored in the host variable.
- 07006 – This code is returned when the host variable type is not compatible with the corresponding column type.
- 07009 – This code is returned when the number of the columns is greater than the number of corresponding host variables.
- 08001 – This code is returned when the database server is not running.
- 08S01 – This code is returned when the connection with the database server is interrupted.
- 21S01 – This code is returned when the number of columns is not same as the number of corresponding input host variables for an INSERT statement.
- 22002 – This code is returned when NULL data are returned and no indicator variable is being used to detect NULL data.
- HY000 – This code indicates a general error.
- HY001 – This code is returned when a memory allocation error occurs.
- HY009 – This code is returned when the host variable and the indicator variable are both NULL pointers.
- HY010 – This code is returned when an attempt is made to fetch records using a cursor that has not been opened.
- HY090 – This code is returned when the value of the indicator variable is invalid.

8.5 WHENEVER Statement

APRE provides the WHENEVER statement for use in handling runtime errors.

8.5.1 Syntax

```
EXEC SQL WHENEVER <condition> <action>;
```

8.5.1.1 Arguments

<condition>: This is the result of execution of an embedded SQL statement.

<action>: This is the action to take in response to the result of execution of the embedded SQL statement.

8.5.2 Conditions

The following conditions can be set in a WHENEVER statement:

8.5.2.1 SQLERROR

This condition is used to detect the occurrence of an error, meaning a sqlca.sqlcode value of SQL_ERROR, during the execution of an embedded SQL statement.

8.5.2.2 NOT FOUND

This condition is used to detect the state in which no records are returned in response to the execution of a SELECT or FETCH statement, at which time the value of sqlca.sqlcode is SQL_NO_DATA.

8.5.3 Actions

If the result of execution of an embedded SQL statement matches the condition specified in the WHENEVER statement, the action specified here will be taken.

The following actions can be specified in the WHENEVER statement:

8.5.3.1 CONTINUE

This specifies that the condition is to be ignored and execution is to continue.

8.5.3.2 DO BREAK

This specifies that the current loop construct is to be exited, and that execution is to continue. This has the same effect as using the `break;` command in a loop construct. This action can only be specified within a loop construct, and a WHENEVER statement specifying the action will only have an effect within the loop.

8.5.3.3 DO CONTINUE

This specifies that control is to be passed to the next iteration of the current loop construct, and that execution is to continue. This has the same effect as using the `continue;` command in a loop construct. This action can only be specified within a loop construct, and a WHENEVER statement specifying the action will only have an effect within the loop.

8.5.3.4 DO *function_name*

This calls the function specified using *function_name*.

8.5.3.5 GOTO *label_name*

This specifies that control is to be passed to the statement immediately following *label_name*, and that execution is to continue.

8.5.3.6 STOP

This specifies that the connection with the database server is to be closed, and that the application is to be shut down.

8.5.4 Description

The scope of applicability of a WHENEVER statement is not determined by the flow of execution of the application. A WHENEVER statement is valid only within the current file.

The WHENEVER statement must precede any embedded SQL statements to which it is intended to apply. That is, all embedded SQL statements that follow a WHENEVER statement in the source file will be tested.

A WHENEVER statement tests the results of execution of all embedded SQL statement in the routine in which it is declared and all routines within that routine). Therefore, whenever the result of execution of any embedded SQL statement in this scope matches the condition in the WHENEVER statement, the corresponding action will be taken.

A WHENEVER statement that checks for the SQLERROR condition and a WHENEVER statement that checks for the NOT FOUND condition can coexist without having any effect on each other.

When execution control moves out of the routine in which a WHENEVER statement was declared, the WHENEVER statement has no further effect. From that point onward, embedded SQL statements will be affected by WHENEVER statements located in the current routine or higher routines.

If two WHENEVER statements that listen for the same condition are present within the same routine, the WHENEVER statement that appeared first will have no effect, and the more recent WHENEVER statement will apply.

If two WHENEVER statements that check for the same condition exist, but have different scopes of applicability, the WHENEVER statement having the broader scope (i.e. the statement declared in an outer routine) will have no effect, and the WHENEVER statement having the narrower scope (i.e. the statement declared in an inner routine) will apply.

WHENEVER statements are connection-independent. In other words, a WHENEVER statement in an

application with more than one connection affects all embedded SQL statements within its scope of applicability, regardless of the connection to which the embedded SQL statements pertain.

A WHENEVER statement that has a global scope will affect all embedded SQL statements in the file in which it appears.

8.6 Sample Programs

8.6.1 runtime_error_check.sc

This example can be found at $ALTIBASE_HOME/sample/APRE/runtime_error_check.sc

8.6.2 Result of Execution

```
$ is -f schema/schema.sql
$ make runtime_error_check
$ ./runtime_error_check
<RUNTIME ERROR CHECK>
---------------------------------------------------
[SQL_SUCCESS]
---------------------------------------------------
sqlca.sqlcode = 0
----------------------------------------------------------
[SQL_SUCCESS_WITH_INFO With SQLSTATE=01004]
---------------------------------------------------
sqlca.sqlcode = 1
sqlca.sqlerrm.sqlerrmc = String data right-truncated.
SQLSTATE = 01004
SQLCODE = 1
---------------------------------------------------
[SQL_ERROR With SQLSTATE=22002]
---------------------------------------------------
sqlca.sqlcode = -1
sqlca.sqlerrm.sqlerrmc = Indicator variable required but not supplied.
SQLSTATE = 22002
SQLCODE = -331841
---------------------------------------------------
[SQL_NO_DATA With SELECT]
---------------------------------------------------
sqlca.sqlcode = 100
sqlca.sqlerrm.sqlerrmc = Not found data
SQLSTATE = 02000
SQLCODE = 100
---------------------------------------------------
[SQL_NO_DATA With FETCH]
----------------------------------------------------------
sqlca.sqlcode = 100
sqlca.sqlerrm.sqlerrmc = Not found data
SQLSTATE = 02000
SQLCODE = 100
2 rows fetched
---------------------------------------------------
[SQL_ERROR]
---------------------------------------------------
sqlca.sqlcode = -1
sqlca.sqlerrm.sqlerrmc = The row already exists in a unique index.
SQLSTATE = 23000
SQLCODE = -69720
---------------------------------------------------
[SQL_ERROR With SQLSTATE=HY010]
---------------------------------------------------
sqlca.sqlcode = -1
sqlca.sqlerrm.sqlerrmc = The cursor must be opened to fetch rows.
SQLSTATE = HY010
SQLCODE = -1
```

```
----------------------------------------------------
[sqlca.sqlerrd[2]]
----------------------------------------------------
sqlca.sqlcode = 0
sqlca.sqlerrd[2] = 12
----------------------------------------------------
sqlca.sqlerrd[3] With Array In-Binding]
----------------------------------------------------
sqlca.sqlcode = 0
sqlca.sqlerrd[2] = 12
sqlca.sqlerrd[3] = 3
```

8.6.3 whenever1.sc

This example can be found at $ALTIBASE_HOME/sample/APRE/whenever1.sc

8.6.4 whenever2.sc

This example can be found at $ALTIBASE_HOME/sample/APRE/whenever2.sc

8.6.5 Result of Execution

```
$ is -f schema/schema.sql
$ make whenever
$ ./whenever
<WHENEVER>
Successful connection
----------------------------------------------------
DNO DNAME DEP_LOCATION MGR_NO
----------------------------------------------------
1001 PAPER TEAM New York 16
1002 RESEARCH DEVELOPMENT DEPT 2 Sydney 13
1003 SOLUTION DEVELOPMENT DEPT Osaka 14
2001 QUALITY ASSURANCE DEPT Seoul 17
3001 CUSTOMER SUPPORT DEPT London 4
3002 PRESALES DEPT Peking 5
4001 MARKETING DEPT Brasilia 8
4002 BUSINESS DEPT Palo Alto 7
```

9 Using Cursors

9.1 Overview

When it is expected that a query will return multiple records, a cursor can be declared and used to manipulate the records.

APRE supports the use of various embedded SQL statements for declaring and managing cursors.

Briefly, the Cursor-related SQL statements that are available in APRE are the DECLARE CURSOR statement, the OPEN statement, the FETCH statement, the CLOSE statement, and the CLOSE RELEASE statement, each of which provides a different cursor-related functionality.

9.1.1 Order of Execution of Cursor-Related SQL Statements

The order in which SQL statements for managing cursors are executed is as follows:

1. DECLARE CURSOR
2. OPEN
3. FETCH

   The FETCH statement is repeatedly executed to retrieve all records that satisfy the given conditions until the result of execution is SQL_NO_DATA.

4. CLOSE or CLOSE RELEASE

9.1.2 Considerations

If an OPEN, FETCH, CLOSE, or CLOSE RELEASE statement that references a cursor that has not been declared is executed, an error indicating that the cursor does not exist will be raised.

It is possible to declare more than one cursor with the same name within one application. When doing so, only the most recently declared cursor will be valid. This means that OPEN, FETCH, CLOSE, and CLOSE RELEASE statements will apply to the most recently declared cursor.

9.2 Cursor-Related SQL Statements

Each cursor-related SQL statement is defined and described below in detail.

9.2.1 DECLARE CURSOR

This statement is used to declare a cursor.

9.2.1.1 Syntax

```
EXEC SQL DECLARE <cursor name> CURSOR FOR <cursor specification>;
```

9.2.1.2 Arguments

<*cursor name*>: This is the name of the cursor. It can be a maximum of 50 bytes long. It must start with an alphabetic character (a ~ z, A ~ Z) or the underscore character ("_").

<*cursor specification*>: This is an SQL SELECT statement of ALTIBASE HDB. For complete information on authoring SELECT statements, please refer to the *ALTIBASE HDB SQL Reference*.

9.2.1.3 Description

The DECLARE CURSOR statement must be executed before any other cursor-related SQL statements. If another statement that references a cursor that has not been declared is executed, an error indicating that the cursor does not exist will be raised.

When the DECLARE CURSOR statement is executed, all SQL statement preparation tasks, such as syntax checking, semantics checking, optimization, and execution plan creation, are conducted on the server. (This is similar to the functionality of the SQLPrepare ODBC statement.) The SQL statement need only be prepared in advance one time in order to be executed multiple times using OPEN CURSOR (which is like the SQLExecute ODBC statement).

9.2.1.4 Limitations

All of the limitations that apply to the SELECT ALTIBASE HDB SQL statement also apply to the DECLARE CURSOR statement.

9.2.1.5 Example

The following example shows how to declare a cursor for retrieving all of the records in the *departments* table.

```
< Sample Program: cursor1.sc >
EXEC SQL DECLARE DEPT_CUR CURSOR FOR
  SELECT *
  FROM DEPARTMENTS;
```

9.2.2 OPEN

This statement is used to open a cursor.

9.2.2.1 Syntax

```
EXEC SQL OPEN <cursor name>;
```

9.2.2.2 Arguments

<*cursor name*>: This is the name of the cursor to open.

9.2.2.3 Description

The OPEN statement executes the SQL statement that was specified using the DECLARE CURSOR statement.

The SELECT statement that is executed using the OPEN statement was previously prepared for execution on the database server when the DECLARE CURSOR statement was executed. When the OPEN statement is executed, the server searches the corresponding table(s) for records that satisfy the conditions in the WHERE clause.

9.2.2.4 Example

The following example shows the statement that is used to open a cursor called *DEPT_CUR*.

```
< Sample Program: cursor1.sc >
EXEC SQL OPEN DEPT_CUR;
```

9.2.3 FETCH

This statement is used to read column values from an open cursor and store them in corresponding host variables.

9.2.3.1 Syntax

```
EXEC SQL FETCH <cursor name>
INTO <host_var_list>;
```

9.2.3.2 Arguments

<*cursor name*>: This is the name of the cursor.

<*host_var_list*>: This is a list of output host variables and output indicator variables.

9.2.3.3 Description

The FETCH statement first instructs the cursor to move to the next record, and then stores that record's column values in corresponding host variables.

9.2.3.4 Result of Execution

The two possible results of execution of a FETCH statement are SQL_SUCCESS and SQL_NO_DATA, each of which is described below.

SQL_SUCCESS

This result indicates that the value retrieved by the FETCH operation was successfully stored in the corresponding host variable, and that there are still data waiting to be returned on the database server.

Applications are typically written such that they will continue to fetch additional records when the result of a FETCH operation is SQL_SUCCESS.

SQL_NO_DATA

This result indicates that nothing was retrieved by the FETCH operation and that no data are stored in the corresponding host variable. The contents of the host variable are therefore meaningless (i.e. a garbage value.)

This result means one of two things: either that all records that satisfy the given conditions have been returned from the database server, or that there were originally no records that satisfied the given conditions.

9.2.3.5 Example

This example shows the use of the previously declared and opened *DEPT_CUR* cursor to fetch records. Each of the returned column values is stored in a corresponding element of the *s_department* structure. The *s_dept_ind* structure-type indicator variable can be used to check whether any of the returned column values is NULL. The `while` loop continues to perform the FETCH operation and retrieve records that satisfy the conditions until SQL_NO_DATA is returned.

< Sample Program: hostvar.h >

```
EXEC SQL BEGIN DECLARE SECTION;
typedef struct department
{
  short dno;
  char dname[30+1];
  char dep_location[9+1];
  int mgr_no;
} department;
typedef struct dept_ind
{
  int dno;
  int dname;
  int dep_location;
  int mgr_no;
} dept_ind;
EXEC SQL END DECLARE SECTION;
```

< Sample Program: cursor1.sc >

```
/* specify path of header file */
EXEC SQL OPTION (INCLUDE=./include);
/* include header file for precompile */
EXEC SQL INCLUDE hostvar.h;
```

```
EXEC SQL BEGIN DECLARE SECTION;
  /* declare host variables */
  department s_department;
  /* structure indicator variables */
  dept_ind s_dept_ind;
EXEC SQL END DECLARE SECTION;

while(1)
{
  EXEC SQL FETCH DEPT_CUR
    INTO :s_department :s_dept_ind;
  if (sqlca.sqlcode == SQL_SUCCESS)
  {
    printf("%d %s %s %d\n",
    s_department.dno, s_department.dname,
    s_department.dep_location,
    s_department.mgr_no);
  }
  else if (sqlca.sqlcode == SQL_NO_DATA)
  {
    break;
  }
  else
  {
    printf("Error : [%d] %s\n", SQLCODE, sqlca.sqlerrm.sqlerrmc);
    break;
  }
}
```

9.2.4 CLOSE

This statement is used to close a cursor.

9.2.4.1 Syntax

```
EXEC SQL CLOSE <cursor name>;
```

9.2.4.2 Arguments

<*cursor name*>: This is the name of the cursor to close.

9.2.4.3 Description

If the CLOSE statement is executed when there are still data left to return on the database server (i.e. when not all of the records have been fetched), then the unfetched results will be discarded. In other words, once the CLOSE statement has been executed, the FETCH statement cannot be executed using that cursor. If it is desired to use the cursor to perform another FETCH operation, it will be necessary to open the cursor before executing the FETCH statement again.

If the CLOSE statement is executed when there are no more data left to return on the database server (i.e. when all of the records have been fetched), then the CLOSE statement has absolutely no effect. Therefore, if all of the records returned by an OPEN statement have been retrieved from the database server, the CLOSE statement can be safely omitted.

When the CLOSE statement is executed, the resources allocated to the cursor are not released. Addi-

tionally, the results of the SQL statement preparation tasks that were conducted when the DECLARE CURSOR statement was executed are saved. To use this prepared SQL statement after the CLOSE statement has been executed, omit the DECLARE CURSOR statement and execute the OPEN statement using the same cursor name.

9.2.4.4 Example

The following example shows the use of the CLOSE statement to close the *DEPT_CUR* cursor.

```
< Sample Program: cursor1.sc >
EXEC SQL CLOSE DEPT_CUR;
```

9.2.5 CLOSE RELEASE

This statement is used to close a cursor and release all of the resources that were allocated to the cursor.

9.2.5.1 Syntax

```
EXEC SQL CLOSE RELEASE <cursor name>;
```

9.2.5.2 Arguments

<*cursor name*>: This is the name of the cursor.

9.2.5.3 Description

The CLOSE RELEASE statement releases the resources allocated to the cursor and deletes the results of the SQL statement preparation tasks that were conducted when the DECLARE CURSOR statement was executed. If there are still data left to return on the database server when the CLOSE RELEASE statement is executed, then the unfetched results will be discarded. If it is desired to use the same cursor name after the CLOSE RELEASE statement has been executed, it will be necessary to execute the DECLARE CURSOR statement, followed by the OPEN statement. In other words, once the CLOSE RELEASE statement has been executed, the OPEN statement cannot be executed using that cursor name.

9.2.5.4 Example

In the following example, the CLOSE RELEASE statement is executed on the *EMP_CUR* cursor. At this time, the SQL statement preparations that were made when the DECLARE *EMP_CUR* CURSOR statement was executed will be discarded, and the resources allocated to the *EMP_CUR* cursor will be released.

```
< Sample Program: cursor2.sc >
EXEC SQL CLOSE RELEASE EMP_CUR;
```

9.3 Reusing a Cursor Name

This section explains how to use the same cursor name repeatedly. It sets forth the order in which to perform tasks and highlights some important considerations to keep in mind when reusing a cursor name.

9.3.1 Relationships between Cursor-Related Statements

The following describes the order in which cursor-related statements must be executed when reusing a cursor name. In detail, it sets forth the cursor-related statements that can precede each cursor-related statement.

- DECLARE CURSOR

  When reusing a cursor name, the DECLARE CURSOR statement must be executed after the CLOSE statement or the CLOSE RELEASE statement.

- OPEN

  When reusing a cursor name, the OPEN statement must be executed after the CLOSE statement. If all records have been fetched, it can also be executed after the FETCH statement.

- FETCH

  When reusing a cursor name, the FETCH statement must be executed after the OPEN statement. It can also be executed after another FETCH statement if the result of execution of the previous FETCH statement was SQL_SUCCESS.

- CLOSE

  When reusing a cursor name, the CLOSE statement can be executed after the DECLARE CURSOR statement, the OPEN statement, or the FETCH statement. When it is executed after a FETCH statement, it doesn't matter whether the result of execution of the FETCH statement was SQL_SUCCESS or SQL_NO_DATA.

- CLOSE RELEASE

  When reusing a cursor name, the CLOSE RELEASE statement can be executed after any other statement. When it is executed after a FETCH statement, it doesn't matter whether the result of execution of the previous FETCH statement was SQL_SUCCESS or SQL_NO_DATA.

9.3.2 Cursor-Related SQL Statements and Host Variables

The following describes how cursor-related SQL statements must be used depending on whether the input host variables used to declare the cursor are global or local in scope.

- If the input host variables in the DECLARE CURSOR statement are global in scope, then the OPEN statement can be executed after the CLOSE statement when reusing a cursor name.

- If a host variable used in a DECLARE CURSOR statement is local in scope, that is, if the host variable was declared inside a function, then in order to use the same cursor name, the DECLARE CURSOR statement must be executed after the CLOSE statement.

The reason for this limitation is that the values of the host variable pointers used in the DECLARE CURSOR statement are stored internally when the DECLARE CURSOR statement is executed, and these stored values are used when the OPEN statement is executed. Therefore, if these host variables are local, then if the function is exited and then called again, the pointer values may be changed, and thus their values may no longer be valid when the OPEN statement is executed. This means that it is necessary to execute the DECLARE CURSOR statement to save the pointer values every time the function is called. Additionally, the local host variables must be declared in the function containing the DECLARE CURSOR and OPEN statements.

9.3.3 The CLOSE and CLOSE RELEASE Statements

The difference between the CLOSE and CLOSE RELEASE statements is described below:

- To reuse the name of a cursor that was released using the CLOSE RELEASE statement, it is necessary to execute the DECLARE CURSOR statement again. The reason for this is that when the CLOSE RELEASE statement is executed, all of the information and resources related to the cursor are deleted, so it is necessary to execute the DECLARE CURSOR statement to allocate necessary resources and prepare for the execution of the SQL statement.

  Therefore, when it is desired to reuse a cursor, in most cases it is more appropriate to execute the CLOSE statement, rather than the CLOSE RELEASE statement.

- After all results have been fetched (i.e. when the result returned by the FETCH statement is SQL_NO_DATA), it is possible to execute either the CLOSE statement or the CLOSE RELEASE statement. When planning to reuse the cursor, the CLOSE statement is more appropriate, whereas the CLOSE RELEASE statement is more appropriate when it is not expected that the cursor will be reused. It is possible to execute the CLOSE RELEASE statement after the CLOSE statement has been executed, but this is somewhat wasteful because the cursor closing operation is performed twice.

- In summary, the CLOSE statement is more appropriate when expecting to reuse the cursor, and the CLOSE RELEASE statement is more appropriate when not expecting to reuse it. In practice, however, there are few cases in which a cursor is not used more than once, so the CLOSE RELEASE statement is almost never used. Reusing a cursor name by repeatedly executing the CLOSE RELEASE, DECLARE CURSOR and OPEN statements has a negative impact on performance.

9.4 Sample Programs

9.4.1 cursor1.sc

This example can be found at $ALTIBASE_HOME/sample/APRE/cursor1.sc

9.4.2 Result of Execution

```
$ is -f schema/schema.sql
$ make cursor1
$ ./cursor1
<CURSOR 1>
----------------------------------------------------
[Declare Cursor]
----------------------------------------------------
Successfully declared cursor
----------------------------------------------------
[Open Cursor]
----------------------------------------------------
Successfully opened cursor
----------------------------------------------------
[Fetch Cursor]
----------------------------------------------------
DNO DNAME DEP_LOCATION MGR_NO
----------------------------------------------------
1001 RESEARCH DEVELOPMENT DEPT 1 New York 16
1002 RESEARCH DEVELOPMENT DEPT 2 Sydney 13
1003 SOLUTION DEVELOPMENT DEPT Osaka 14
2001 QUALITY ASSURANCE DEPT Seoul 17
3001 CUSTOMER SUPPORT DEPT London 4
3002 PRESALES DEPT Peking 5
4001 MARKETING DEPT Brasilia 8
4002 BUSINESS DEPT Palo Alto 7
----------------------------------------------------
[Close Cursor]
----------------------------------------------------
Successfully closed cursor
```

9.4.3 cursor2.sc

This example can be found at $ALTIBASE_HOME/sample/APRE/cursor2.sc

9.4.4 Result of Execution

```
$ is -f schema/schema.sql
$ make cursor2
$ ./cursor2
<CURSOR 2>
----------------------------------------------------
[Declare Cursor]
----------------------------------------------------
Successfully declareed cursor
----------------------------------------------------
[Open Cursor]
----------------------------------------------------
```

```
Successfully opened cursor
----------------------------------------------------
[Fetch Cursor]
----------------------------------------------------
ENO DNO SALARY
----------------------------------------------------
2 -1 1500000.00
3 1001 2000000.00
4 3001 1800000.00
5 3002 2500000.00
6 1002 1700000.00
7 4002 500000.00
9 4001 1200000.00
10 1003 4000000.00
11 1003 2750000.00
12 4002 1890000.00
13 1002 980000.00
14 1003 2003000.00
15 1003 1000000.00
16 1001 2300000.00
17 2001 1400000.00
18 4001 1900000.00
19 4002 1800000.00
----------------------------------------------------
[Close Release Cursor]
----------------------------------------------------
Successfully closed and released cursor
```

9.4 Sample Programs

10 Using Arrays in Embedded SQL Statements

10.1 Overview

This chapter explains how to declare and use array-type host variables in embedded SQL statements.

10.1.1 Definition and Declaration

The term “array host variable” refers to a one-dimensional or two-dimensional array of a data type that can be used as a host variable, that is itself declared for use as a host variable.

One- or two-dimensional arrays can be declared for use with character types and the `varchar` type, whereas only one-dimensional arrays can be declared for use with other data types. One exception is that an array of pointers cannot be declared.

10.1.1.1 Example

Various examples that illustrate how array host variables are declared are shown below.

[Example 1] The following example shows how to declare character-type and numeric-type arrays as host variables.

< Sample Program: arrays1.sc >

```
EXEC SQL BEGIN DECLARE SECTION;
char a_gno[3][10+1];
char a_gname[3][20+1];
char a_goods_location[3][9+1];
int a_stock[3];
double a_price[3];
EXEC SQL END DECLARE SECTION;
```

[Example 2] The following example shows how to declare an array of structures as a host variable.

< Sample Program: hostvar.h >

```
EXEC SQL BEGIN DECLARE SECTION;
typedef struct goods
{
  char gno[10+1];
  char gname[20+1];
  char goods_location[9+1];
  int stock;
  double price;
} goods;
EXEC SQL END DECLARE SECTION;
```

< Sample Program: arrays1.sc >

```
EXEC SQL BEGIN DECLARE SECTION;
goods a_goods[3];
EXEC SQL END DECLARE SECTION;
```

[Example 3] The following example shows how to declare a structure that contains array elements and use it as a host variable.

< Sample Program: arrays1.sc >

```
EXEC SQL BEGIN DECLARE SECTION;
struct
{
  char gno[3][10+1];
  char gname[3][20+1];
  char goods_location[3][9+1];
  int stock[3];
  double price[3];
} a_goods2;
EXEC SQL END DECLARE SECTION;
```

10.1.2 Advantages

Using array-type host variables will have a positive impact on system performance. A look at one or two examples will give you an idea of the magnitude of the performance improvement that can be expected.

Compare the use of an array-type host variable with the use of a non-array-type host variables in the execution of an INSERT statement. Suppose for example that it is desired to insert 1000 records. If an array-type host variable having 1000 elements is used, it is only necessary to execute an INSERT statement one time to insert all 1000 records. In contrast, when using a non-array-type host variable, it would be necessary to execute an INSERT statement 1000 times in order to insert all 1000 records. This requires 1000 separate communication events with the database server. It is thus evident that the use of an array-type host variable greatly reduces the consumption of network resources compared to when using a non-array-type host variable.

Now compare the use of an array-type host variable with the use of a non-array-type host variable in the execution of a FETCH statement. In order to fetch 1000 records into an array-type host variable having 1000 elements, it will only be necessary to execute the FETCH statement one time, and all 1000 records will be fetched in sequence into the array, starting with the 0th element. When using a non-array-type host variable, it would be necessary to execute the FETCH statement 1000 times in order to fetch all 1000 records; however, this would not entail a separate communication event with the database server every time the FETCH statement was executed. The reason for this is that internally a certain number of records are retrieved from the database in advance and saved, and every time the FETCH statement is executed, one previously saved record is assigned to the host variable. This shows that a notable improvement in performance cannot be expected when using array-type host variables to execute a FETCH statement. Only a slight performance improvement, attributable to the decrease in the number of times the FETCH statement is executed, can be expected.

10.1.3 CONNTYPE and Host Array Variables

10.1.3.1 CONNTYPE

The CONNTYPE option is used to determine the method of communication with the database server, and is specified when attempting to establish a connection with the database server. The value of the CONNTYPE option has a strong effect on performance. The magnitude of this effect varies depending on whether array-type host variables are being used.

For information on how to set the CONNTYPE option, please refer to 7.2.1 CONNECT.

10.1.3.2 Supported Connection Types

As was explained fully in 7.2.1 CONNECT, the supported connection types are TCP, UNIX and IPC.

10.1.3.3 Relationship between CONNTYPE and Host Variable Array Size

Normally, the IPC connection type realizes the best performance, followed in descending order by the UNIX and TCP connection types. However, when using array-type input host variables, this is not necessarily the case. Therefore, when using array-type input host variables, it is suggested that you test each of the connection methods with various array sizes to determine the combination that yields the best performance in your environment.

10.2 Using Host Array Variables in Embedded SQL Statements

Array-type host variables can be used in embedded SQL statements in various ways.

10.2.1 INSERT

The array types that can be used with INSERT statements are as follows:

- Simple arrays
- Arrays of structures
- Structures comprising arrays as individual elements thereof

10.2.1.1 Example

The following example shows the use of an array-type host variable as an input host variable in an INSERT statement.

```
< Sample Program: arrays1.sc >
EXEC SQL BEGIN DECLARE SECTION;
  char a_gno[3][10+1];
  char a_gname[3][20+1];
  char a_goods_location[3][9+1];
  int a_stock[3];
  double a_price[3];
EXEC SQL END DECLARE SECTION;

strcpy(a_gno[0], "X111100001");
strcpy(a_gno[1], "X111100002");
strcpy(a_gno[2], "X111100003");
strcpy(a_gname[0], "XX-201");
strcpy(a_gname[1], "XX-202");
strcpy(a_gname[2], "XX-203");
strcpy(a_goods_location[0], "AD0010");
strcpy(a_goods_location[1], "AD0011");
strcpy(a_goods_location[2], "AD0012");
a_stock[0] = 1000;
a_stock[1] = 1000;
a_stock[2] = 1000;
a_price[0] = 5500.21;
a_price[1] = 5500.45;
a_price[2] = 5500.99;

EXEC SQL INSERT INTO GOODS
  VALUES (:a_gno, :a_gname, :a_goods_location, :a_stock, :a_price);
```

10.2.2 UPDATE

The array types that can be used with the UPDATE statement are as follows:

- Simple arrays
- Structures comprising arrays as individual elements thereof

10.2.2.1 Limitation

If any of the host variables is an array, all host variables must be arrays, and furthermore, the number of elements in each array must be the same. Arrays of structures cannot be used as host variables in the SET or WHERE clause of UPDATE statements. However, it is possible to use an individual element of one structure that is itself one element in an array of structures in the SET or WHERE clause, as shown in the following example:

```
Example)
EXEC SQL BEGIN DECLARE SECTION;
  int   eno[3];
  short dno[3];
  char  emp_tel[3][15+1];
  struct tag1 { int i1; int i2; int i3; } var1[10];
EXEC SQL END DECLARE SECTION;

EXEC SQL UPDATE EMPLOYEES SET DNO = :dno,
    EMP_TEL = :emp_tel
  WHERE ENO = :eno;  // acceptable

EXEC SQL UPDATE T1
  SET I1 = :var1[0].i1, I2 = :var1[0].i2
  WHERE I1 = :var1[0].i3;  // acceptable
```

10.2.2.2 Example

The following example shows the use of an array-type host variable as an input host variable in an UPDATE statement.

```
< Sample Program: arrays1.sc >
EXEC SQL BEGIN DECLARE SECTION;
  int a_eno[3];
  short a_dno[3];
  char a_emp_tel[3][15+1];
EXEC SQL END DECLARE SECTION;

a_eno[0] = 10;
a_eno[1] = 11;
a_eno[2] = 12;
a_dno[0] = 2001;
a_dno[1] = 2001;
a_dno[2] = 2001;
strcpy(a_emp_tel[0], "01454112366");
strcpy(a_emp_tel[1], "0141237768");
strcpy(a_emp_tel[2], "0138974563");

EXEC SQL UPDATE EMPLOYEES
  SET DNO = :a_dno,
    EMP_TEL = :a_emp_tel
  WHERE ENO = :a_eno;
```

10.2.3 DELETE

The array types that can be used with the DELETE statement are as follows:

- Simple arrays
- Structures comprising arrays as individual elements thereof

10.2.3.1 Limitation

If any of the host variables is an array, all host variables must be arrays, and furthermore, the number of elements in each array must be the same. Arrays of structures cannot be used as host variables in the WHERE clause of a DELETE statement. However, it is possible to use an individual element of one structure that is itself one element in an array of structures in the WHERE clause, as shown in the following example:

```
Example)
EXEC SQL BEGIN DECLARE SECTION;
  int   eno[3];
  short dno[3];
  char  emp_tel[3][15+1];
  struct tag1 { int i1; int i2; int i3; } var1[10];
EXEC SQL END DECLARE SECTION;

EXEC SQL DELETE FROM EMPLOYEES
  WHERE ENO = :eno and DNO = :dno;  // acceptable

EXEC SQL DELETE FROM T1
  WHERE I1 = :var1[0].i1 AND
    I2 = :var1[0].i2 AND
    I3 = :var1[0].i3;  // acceptable
```

10.2.3.2 Example

The following example shows the use of an array-type host variable as an input host variable in a DELETE statement.

```
< Sample Program: arrays1.sc >
EXEC SQL BEGIN DECLARE SECTION;
  short a_dno[3];
EXEC SQL END DECLARE SECTION;

a_dno[0] = 4001;
a_dno[1] = 4002;
a_dno[2] = 2001;
EXEC SQL DELETE FROM EMPLOYEES
  WHERE DNO = :a_dno;
```

10.2.4 SELECT

The array types that can be used with the SELECT statement are as follows. The array types listed below can also be used in FETCH statements, and the same limitations apply.

- Simple arrays
- Arrays of structures
- Structures comprising arrays as individual elements thereof

10.2.4.1 Limitation

If any of the host variables in the INTO clause of a SELECT statement is an array, all of the host variables in the INTO clause must be arrays. Array-type input host variables cannot be used in the WHERE clause of SELECT embedded SQL statements.

```
Example)
EXEC SQL BEGIN DECLARE SECTION;
  int var1;
  int var2[10];
  int var3[10];
EXEC SQL END DECLARE SECTION;

EXEC SQL SELECT * INTO :var1
  FROM T1 WHERE i1 = :var3;  // unacceptable
// or
EXEC SQL SELECT * INTO :var2
  FROM T1 WHERE i1 = :var3;  // unacceptable
```

If the number of records that are returned is greater than the size of the array, an error indicating that too many rows were returned will be raised.

10.2.4.2 Example

The following example shows the use of an array-type host variable as an output host variable in a SELECT statement. Note that the input host variable is not an array.

< Sample Program: arrays2.sc >

```
EXEC SQL BEGIN DECLARE SECTION;
  short s_dno;
  short a_dno[5];
  char a_dname[5][30+1];
  char a_dep_location[5][9+1];
EXEC SQL END DECLARE SECTION;

s_dno = 3000;
EXEC SQL SELECT DNO, DNAME, DEP_LOCATION
  INTO :a_dno, :a_dname, :a_dep_location
  FROM DEPARTMENTS
  WHERE DNO > :s_dno;
```

10.2.5 FOR Clause

Sometimes, it is desired to process only some of the array elements in an embedded SQL statement that uses an array-type input host variable. For example, when using an array-type input host variable to fetch data and then insert the fetched data back into the database using the same host variable, the number of fetched data items may be smaller than the size of the array. In such cases, the number of elements to be inserted can be set using a FOR clause.

The FOR clause plays the role of determining the number of array elements to process when using an array-type input host variable.

When using a FOR clause, it takes priority over the size of the array-type host variable in determining the number of array elements that are processed. For example, when the size of a host variable array is 10 and the number of array elements to be processed, as specified by a FOR clause, is 5, only five of the elements in the array-type host variable, namely the 0th to 4th elements, will be processed.

The use of the FOR clause is particularly convenient in situations where the number of array elements to process changes every time the embedded SQL statement is executed.

FOR clauses can be used with the following kinds of embedded SQL statements:

- INSERT
- UPDATE
- DELETE

10.2.5.1 Syntax

EXEC SQL FOR <:*host_var* | *constant*> { INSERT … | UPDATE … | DELETE … }

10.2.5.2 Arguments

- <:*host_var*>: This is used to set the number of array elements to be processed.

  host_var does not need to be declared in the host variable declaration section.

- <*constant*>: This is used to set a fixed number of array elements to be processed.

10.2.5.3 Considerations

- The value specified in the FOR clause must be at least one.

```
Example)
EXEC SQL BEGIN DECLARE SECTION;
  int cnt;
  int var1[10];
  int var2[10];
EXEC SQL END DECLARE SECTION;

cnt = 5; // OK
EXEC SQL FOR :cnt INSERT INTO T1
  VALUES (:var1, :var2);

cnt = 0; // unacceptable
EXEC SQL FOR :cnt INSERT INTO T1
  VALUES (:var1, :var2);

cnt = -1; // unacceptable
EXEC SQL FOR :cnt INSERT INTO T1
  VALUES (:var1, :var2);
```

- In a FOR clause, Input host variables do not need to be array-type variables.

```
Example)
EXEC SQL BEGIN DECLARE SECTION;
  int cnt;
  int var1;
EXEC SQL END DECLARE SECTION;

cnt = 1;
EXEC SQL FOR :cnt INSERT INTO T1
  VALUES (:var1); // acceptable
```

10.2.5.4 Examples

Examples of the use of FOR clauses in various kinds of SQL statements follow.

[Example 1] The following example shows the use of a FOR clause in an INSERT statement. The number of array elements to be processed is determined by the host variable *cnt* in the FOR clause, and thus only the 0th and 1st elements in the *a_goods* array are inserted into the GOODS table.

< Sample Program: hostvar.h >

```
XEC SQL BEGIN DECLARE SECTION;
typedef struct goods
{
  char gno[10+1];
  char gname[20+1];
  char goods_location[9+1];
  int stock;
  double price;
} goods;
EXEC SQL END DECLARE SECTION;
```

< Sample Program: arrays1.sc >

```
EXEC SQL BEGIN DECLARE SECTION;
  goods a_goods[3];
EXEC SQL END DECLARE SECTION;

int cnt;
cnt = 2;
EXEC SQL FOR :cnt INSERT INTO GOODS VALUES (:a_goods);
```

[Example 2] The following example shows the use of a FOR clause in an UPDATE statement. The number of array elements to be processed is constant (2), and thus only two elements, starting with the 0th element, will be processed. That is, the *dno* and *emp_tel* columns in the records in the *employees* table for which the value in the *eno* column matches the first two values of *a_employee.eno* will be respectively updated with the 0th and 1st elements of *a_employee.dno* and *a_employee.emp_tel*.

```
< Sample Program: arrays1.sc >
EXEC SQL BEGIN DECLARE SECTION;
struct
{
   int eno[3];
   short dno[3];
   char emp_tel[3][15+1];
} a_employee;
EXEC SQL END DECLARE SECTION;

EXEC SQL FOR 2 UPDATE EMPLOYEES
  SET DNO = :a_employee.dno,
    EMP_TEL = :a_employee.emp_tel,
    JOIN_DATE = SYSDATE
  WHERE ENO = :a_employee.eno;
```

[Example 3] The following example shows the use of a FOR clause in a DELETE statement. The number of array elements to be processed is determined by the host variable *cnt* in the FOR clause, and thus the records in the *employees* table for which the value in the *dno* column matches the first two values of *a_dno* will be deleted.

```
< Sample Program: arrays1.sc >
EXEC SQL BEGIN DECLARE SECTION;
  short a_dno[3];
EXEC SQL END DECLARE SECTION;

int cnt;
cnt = 2;
```

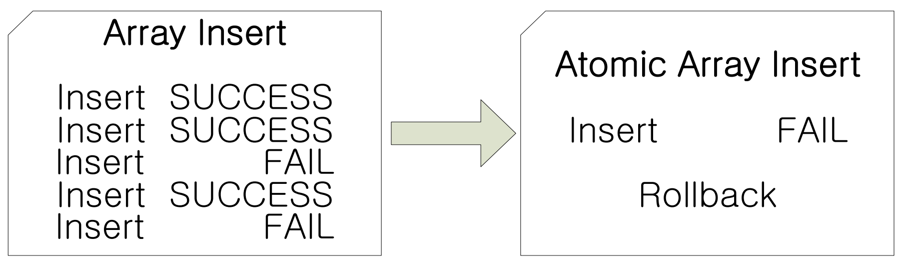
```
EXEC SQL FOR :cnt DELETE FROM EMPLOYEES
  WHERE DNO = :a_dno;
```

10.2.6 ATOMIC FOR Clause

When the ATOMIC FOR Clause is used with an array-type input host variable in an embedded SQL statement, multiple iterations of the statement corresponding to each of the array elements are combined and processed all at the same time using so-called "Atomic Array Insert".

Therefore, when using ATOMIC FOR, if the execution of even one of the iterations fails, then the execution of the entire statement fails. The individual resultant values are never written to disk or shared with other processes. That is, either none of the values are inserted, or all of them are inserted.

Figure 10-1 Values Resulting from Array Insert and Atomic Array Insert Operations



While "Non-Atomic Array Insert" (i.e. the use of an array input host variable with an INSERT embedded SQL statement) already offers the advantage of reduced communication costs, Atomic Array Insert increases performance even further, because it reduces the number of statements that must be executed.

Table 10-1 Difference between Array Insert and Atomic Array Insert

	Array Insert	Atomic Array Insert
Number of Statement Executions	Number of Array Elements	One
Number of Resultant Values	Number of Array Elements	One
Speed	Fast	Faster

10.2.6.1 Syntax

```
EXEC SQL ATOMIC FOR <:host_var | constant> {INSERT … }
```

10.2.6.2 Arguments

<:*host_var*>: This is used to set the number of array elements to be processed. This variable doesn't have to be declared in the host variable declaration section.

<*constant*>: This is used to set a fixed number of array elements to be processed.

10.2.6.3 Considerations

- The ATOMIC FOR clause can only be used with INSERT statements. It cannot be used with any other DML statements.
- The ATOMIC FOR clause can be used with INSERT statements in which data are inserted into LOB type columns, but once the LOB data have been transferred, they cannot be rolled back if an error occurs. In such cases it will be necessary for the user to roll back the LOB data directly using a savepoint.
- There are several other considerations to keep in mind when using the ATOMIC FOR clause, which are set forth in the following table:

Table 10-2 Restrictions on Atomic Array Insert

	Array Insert	Atomic Array Insert
Foreign Key	Operates Normally	Operates Normally
Unique Key	Operates Normally	Operates Normally
Not Null	Operates Normally	Operates Normally
Trigger Each Row	Executed N times	Executed N times
Trigger Each Statement	Executed N times	Executed Once
Partitioned Table	Operates Normally	Operates Normally
Sequence	Executed N times	Executed N times
SYSDATE	Executed N times	Executed Once
LOB Column	Operates Normally	Atomicity cannot be guaranteed when an error occurs
Procedure	Operates Normally	Operates Normally
When a INSERT statement contains a subquery	A new view for the subquery is created N times	The view corresponding to the first execution is reused

10.2.6.4 Example

```
EXEC SQL ATOMIC FOR 20 INSERT INTO T1 VALUES( :data );
```

10.2.7 ONERR Clause

Using this clause with an embedded SQL statement that uses an array-type input host variable enables detection of whether execution corresponding to each of the array elements was successful. This makes it possible to manage the list of elements for which execution failed by defining some management tasks that use DML statements.

10.2.7.1 Syntax

```
EXEC SQL ONERR <:ret_code, :err_code> {INSERT | UPDATE | DELETE}
```

or

```
EXEC SQL ONERR <:ret_code , :err_code>
  FOR <:cnt | constant> {INSERT | UPDATE | DELETE}
```

10.2.7.2 Arguments

<:*ret_code* , :*err_code*>: The result of execution of the SQL statement is saved in the first host variable, *ret_code*. This variable must be declared as a pointer to an array of `short`. The error code is saved in the second host variable, *err_code*. This variable must be declared as a pointer to an array of `int`.

<:*cnt*>: This value is used to specify the number of array elements to be processed. This variable doesn't have to be declared in the host variable declaration section.

<*constant*>: This value is used to specify a fixed number of array elements to be processed.

10.2.7.3 Restriction

- The array-type host variables used in the ONERR clause, *ret_code* and *err_code*, must not be smaller than any of the arrays used in the SQL statement.
- When using the ONERR clause together with the FOR clause, the size of the array-type host variable used in the ONERR clause must not be less than *cnt*, that is, the number of array elements to be processed.

10.2.7.4 Example

```
EXEC SQL ONERR :err_rc , :err_code
  UPDATE T1 SET c2 = c2+1 WHERE c1 = :var1;
EXEC SQL ONERR :err_rc , :err_code FOR :arr_count
  UPDATE T1 SET c2 = c2+1 WHERE c1 = :var1;
```

10.3 sqlca.sqlerrd

When using an array-type host variable in an embedded SQL statement, the value of the sqlca.sqlerrd variable can be checked after execution of the embedded SQL statement. This section explains the meaning of the contents that can be stored in the sqlca.sqlerrd variable.

10.3.1 sqlca.sqlerrd[2]

When using non-array type host variables, this value can be checked after executing UPDATE and DELETE statements.

When using array type host variables, this value can be checked after executing INSERT, UPDATE, DELETE, and SELECT statements.

When the value stored in the `sqlca.sqlcode` variable is SQL_SUCCESS, the meaning of the value stored in the `sqlca.sqlerrd[2]` variable varies depending on the kind of embedded SQL statement that was executed. The following describes the meaning for each kind of embedded SQL statement.

10.3.1.1 INSERT

When not using an array type input host variable, the value of sqlca.sqlerrd[2] will be 1 after successful execution of an INSERT statement. This means simply that one record has been inserted.

When using an array type input host variable, the value of sqlca.sqlerrd[2] will be the number of records that were successfully inserted. Note that for an INSERT statement this value will never be larger than the size of the array.

For example, if an INSERT statement is executed using a host variable of which the array size is 3, and the insertion operations corresponding to all three array elements are successful, then three records will be inserted, and the value stored in sqlca.sqlerrd[2]will be 3. If the insertion operations corresponding to the first two array elements are successful but the insertion operation corresponding to the third array element fails, then two records will be inserted, and this value will be 2.

However, the value stored in sqlca.sqlerrd[2] is somewhat different when using Atomic Array Insert. If the Atomic Array Insert operation is completely successful, this value will be equal to the number of rows that were inserted, i.e. the number of array elements, but if even one insertion operation fails, this value will be 0.

10.3.1.2 UPDATE/DELETE

After a successful UPDATE or DELETE operation, the number of updated or deleted records will be stored in sqlca.sqlerrd[2].

Because there can be more than one record that meets a condition specified using each element of an array-type host variable, this value may be higher than the array size.

For example, assume that you have performed an UPDATE operation using an array-type host variable having three elements, and that the operation was successful for each of the three array elements. If there were three records that satisfied the condition when using the 0th element, two records that satisfied the condition when using the 1st element, and no records that satisfied the condition when using the 2nd element, a total of five records would be updated, so the value stored

in sqlca.sqlerrd[2] would be 5.

10.3.1.3 SELECT/FETCH

If the output host variable is not an array-type host variable, this value will be meaningless, i.e. a garbage value.

If the output host variable is an array-type host variable, the number of records that have been selected (or fetched) at the present moment in time will be stored in sqlca.sqlerrd[2]. Note that this value is not the cumulative number of records fetched using multiple FETCH statements. It is only the number of records that have been fetched by the current statement. Therefore, a value larger than the size of the array will never be observed.

If the number of records that were returned is the same as or smaller than the array size, then the value stored in sqlca.sqlcode will be SQL_SUCCESS, and the number of records that were returned will be stored in sqlca.sqlerrd[2].

If no records were returned, the value stored in sqlca.sqlcode will be SQL_NO_DATA, and zero (0) will be stored in sqlca.sqlerrd[2].

For example, assume that you have performed a SELECT operation using an array-type output host variable having ten (10) elements. If there were five records that met the conditions, those five records would be stored in the output host variable in sequence, starting with the 0th element. At this time, the value of sqlca.sqlcode would be SQL_SUCCESS, and 5 would be stored in sqlca.sqlerrd[2].

10.3.2 sqlca.sqlerrd[3]

After the execution an embedded SQL statement using an array-type input host variable, this variable stores the number of array elements for which execution was successful, regardless of whether the statement is an INSERT, UPDATE, or DELETE statement. Therefore, a value larger than the size of the array will never be observed. If the value of sqlca.sqlcode is SQL_SUCCESS, the value of the sqlca.sqlerrd[3] variable will be equal to the size of the array.

All of the following conditions must be met in order for this variable to contain a meaningful value:

- This value must be checked only after the execution of an embedded SQL statement using an array-type input host variable.
- The statement that was just executed before checking this value must be an INSERT, UPDATE, or DELETE SQL statement, or a stored procedure.

When using Atomic Array Insert, if the Atomic Array Insert operation is completely successful, this value will be 1, but if even one insertion operation fails, this value will be 0.

10.3.2.1 Example

For example, if an UPDATE statement is executed using a host variable of which the array size is 3, and the update operations corresponding to the 0th and 1st array elements are successful but no records are updated by the UPDATE operation corresponding to the 2nd array element, then the value returned in sqlca.sqlcode will not be SQL_SUCCESS and the value returned in sqlca.sqlerrd[3] will be 2. If there were three records that satisfied the condition when using the 0th element and two records that satisfied the condition when using the 1st element, a total of five records would be

updated, so the value stored in sqlca.sqlerrd[2] would be 5.

10.3.3 Considerations

- Unless the value of sqlca.sqlcode is SQL_SUCCESS, the value stored in the sqlca.sqlerrd[2] variable will have no meaning (i.e. will be a garbage value). Therefore, check the value of the sqlca.sqlerrd[2] variable only when the value of sqlca.sqlcode is SQL_SUCCESS.
- When using an array-type host variable in AUTOCOMMIT mode, a "transaction" is not the totality of operations performed using the entire array. Rather, each of the operations corresponding to a single array element is one transaction. Therefore, the changes effected by each of the successful operations corresponding to individual array elements are permanently stored in the database, even if the operations corresponding to some of the other array elements fail.

  For example, if an INSERT statement is executed using a host variable of which the array size is 3, and the insertion operations corresponding to the first two array elements are successful but the insertion operation corresponding to the last array element fails, then two records will be permanently inserted into the table.

10.4 Limitations on the Use of Array-Type Host Variables

There are several factors that limit the use of arrays as host variables. Please keep the following in mind when writing applications:

10.4.1 In the DECLARE section

- Arrays of pointers cannot be declared.

```
Example)
EXEC SQL BEGIN DECLARE SECTION;
  char *var1[10];   // not allowed
EXEC SQL END DECLARE SECTION;
```

- Only single-dimensional arrays can be used as host variables. The exception is that two-dimensional arrays are allowed for the `char` and `varchar` types.

  Example of Acceptable Usage:

```
EXEC SQL BEGIN DECLARE SECTION;
  char var1[10][10];
  int var2[10];
EXEC SQL END DECLARE SECTION;
```

  Example of Unacceptable Usage:

```
EXEC SQL BEGIN DECLARE SECTION;
  char var3[10][10][10];
  int var4[10]10];
EXEC SQL END DECLARE SECTION;
```

10.4.2 In SQL Statements

- Arrays cannot be used as input host variables in SELECT statements and cursor-related statements.

  Example of Unacceptable Usage:

```
EXEC SQL BEGIN DECLARE SECTION;
  int var1[10];
  int var2[10];
  int var3[10];
EXEC SQL END DECLARE SECTION;

EXEC SQL SELECT I1, I2 INTO :var1, :var2
  FROM T1 WHERE I1 = :var3;    // unacceptable
```

10.5 Structures and Arrays

Both arrays of structures and structures containing arrays as constituent elements thereof can be declared and used as host variables.

10.5.1 Arrays of Structures

The following explains how to declare arrays of structures and use them.

10.5.1.1 Advantages

- The use of an array of structures is convenient when using an INSERT statement to insert multiple records into all of the columns in a table.
- Similarly, it is convenient to use an array of structures when using a SELECT or FETCH statement to retrieve multiple records from all of the columns in a table.

10.5.1.2 Disadvantages

- Because an indicator variable cannot be specified for use with an array of structures, it is impossible to use an array of structures when any of the values to be input, or any of the values to be retrieved using a SELECT or FETCH statement, are NULL.

10.5.1.3 Limitations

- Because the use of multi-dimensional arrays as host variables is not supported, an array of structures cannot be used if any of the constituent elements of the structure are arrays.

  Example of Unacceptable Usage:

  ```
  EXEC SQL BEGIN DECLARE SECTION;
    struct tag1 { int i1[10]; int i2[10]; } var1[10];// not allowed
  EXEC SQL END DECLARE SECTION;
  ```

- When using an array of structures as an output host variable in the INTO clause of a SELECT or FETCH statement, only one output host variable can be used. In other words, the array of structures cannot be used with any other output host variables. Therefore, if the host variable to be used in the INTO clause of a SELECT or FETCH statement is an array of structures, the number of elements in the structure must be the same as the number of columns in the select list.
- Similarly, when using an array of structures as an input host variable in the VALUES clause of an INSERT statement, only one input host variable can be used. In other words, the array of structures cannot be used with any other input host variables. Therefore, if the host variable to be used in the VALUES clause of an INSERT statement is an array of structures, the number of elements in the structure must be the same as the number of columns specified in the INSERT statement.

  The foregoing two limitations are due to an internal rule that requires the structure to include all host variables when the host variable is an array of structures.

  Example:

```
EXEC SQL BEGIN DECLARE SECTION;
  struct tag1 { int i1; int i2; } var1[10];
  struct tag1 { int i3; int i4; } var2[10];
  int var3;
EXEC SQL END DECLARE SECTION;

EXEC SQL SELECT I1, I2 INTO :var1
  FROM T1 WHERE I1 = :var3; // acceptable
EXEC SQL SELECT I1, I2, I3, I4 INTO :var1, :var2
  FROM T1 WHERE I1 = :var3; // not allowed
```

- An indicator variable cannot be specified for use with a host variable that is an array of structures. Therefore, when an array of structures is used as an output host variable, it must be guaranteed that no NULL values will be returned.

  Example of Unacceptable Usage:

```
EXEC SQL BEGIN DECLARE SECTION;
  struct tag1 { int i1; int i2; char i3[10]; } var1[10];
  struct tag2 { int i1_ind; int i2_ind; int i3_ind; } var1_ind[10];
EXEC SQL END DECLARE SECTION;

EXEC SQL SELECT * INTO :var1 :var1_ind; // not allowed
```

10.5.1.4 Examples

Various examples of the declaration and use of arrays of structures as host variables are shown below.

[Example 1] The following example shows the use of an array of structures as an input host variable in an INSERT statement.

< Sample Program: hostvar.h >

```
EXEC SQL BEGIN DECLARE SECTION;
typedef struct goods
{
  char gno[10+1];
  char gname[20+1];
  char goods_location[9+1];
  int stock;
  double price;
} goods;
EXEC SQL END DECLARE SECTION;
```

< Sample Program: arrays1.sc >

```
/* specify path of header file */
EXEC SQL OPTION (INCLUDE=./include);
/* include header file for precompiling */
EXEC SQL INCLUDE hostvar.h;

EXEC SQL BEGIN DECLARE SECTION;
  goods a_goods[3];
EXEC SQL END DECLARE SECTION;

strcpy(a_goods[0].gno, "Z111100001");
strcpy(a_goods[1].gno, "Z111100002");
strcpy(a_goods[2].gno, "Z111100003");
strcpy(a_goods[0].gname, "ZZ-201");
strcpy(a_goods[1].gname, "ZZ-202");
```

```
strcpy(a_goods[2].gname, "ZZ-203");
strcpy(a_goods[0].goods_location, "AD0020");
strcpy(a_goods[1].goods_location, "AD0021");
strcpy(a_goods[2].goods_location, "AD0022");
a_goods[0].stock = 3000;
a_goods[1].stock = 4000;
a_goods[2].stock = 5000;
a_goods[0].price = 7890.21;
a_goods[1].price = 5670.45;
a_goods[2].price = 500.99;

EXEC SQL INSERT INTO GOODS VALUES (:a_goods);
```

[Example 2] The following example shows the use of an array of structures as an output host variable in a SELECT statement.

< Sample Program: hostvar.h >

```
EXEC SQL BEGIN DECLARE SECTION;
typedef struct department
{
  short dno;
  char dname[30+1];
  char dep_location[9+1];
  int mgr_no;
} department;
EXEC SQL END DECLARE SECTION;
```

< Sample Program: arrays2.sc >

```
/* specify path of header file */
EXEC SQL OPTION (INCLUDE=./include);
/* include header file for precompiling */
EXEC SQL INCLUDE hostvar.h;

EXEC SQL BEGIN DECLARE SECTION;
  short s_dno;
  department a_department[5];
EXEC SQL END DECLARE SECTION;

s_dno = 2000;
EXEC SQL SELECT * INTO :a_department
  FROM DEPARTMENTS WHERE DNO < :s_dno;
```

10.5.2 Structures Containing Arrays

The following explains how to declare and use structures containing arrays as constituent elements.

10.5.2.1 Advantages

- The use of a structure containing arrays is convenient when using an INSERT statement to insert multiple records into all of the columns in a table.
- Similarly, it is convenient to use a structure containing arrays when using a SELECT or FETCH statement to retrieve multiple records from all of the columns in a table.
- Because indicator variables can be specified for use with structures containing arrays, it is possible to handle NULL values.

- Because it is possible to specify the individual elements of structures as host variables, structures containing arrays can be used in UPDATE statements and in the WHERE clauses of SELECT, UPDATE, and DELETE statements.
- The limitation on the use of arrays of structures as host variables, stating that the array of structures must be the only host variable in the input or output host variable list, does not also apply to the use of structures containing arrays as constituent elements. When a structure containing one or more arrays is used as a host variable, there is no requirement that the structure be the only input or output host variable. That is, structures containing arrays can be freely used together with other host variables in the input host variable list or output host variable list.

10.5.2.2 Example

Various examples of the declaration and use of structures containing arrays as host variables are shown below.

[Example 1] The following example shows the use of a structure containing arrays as an input host variable in an UPDATE statement. Because the value SQL_NULL_DATA is set in the elements of the *a_emp_tel_ind* array, the values in the EMP_TEL column will be overwritten with NULL.

```
< Sample Program: arrays1.sc >
EXEC SQL BEGIN DECLARE SECTION;
struct
{
  int eno[3];
  short dno[3];
  char emp_tel[3][15+1];
} a_employee;
int a_emp_tel_ind[3];
EXEC SQL END DECLARE SECTION;

/* set host variables */
a_employee.eno[0] = 17;
a_employee.eno[1] = 16;
a_employee.eno[2] = 15;
a_employee.dno[0] = 1003;
a_employee.dno[1] = 1003;
a_employee.dno[2] = 1003;
/* set indicator variables */
a_emp_tel_ind[0] = SQL_NULL_DATA;
a_emp_tel_ind[1] = SQL_NULL_DATA;
a_emp_tel_ind[2] = SQL_NULL_DATA;

EXEC SQL UPDATE EMPLOYEES
  SET DNO = :a_employee.dno,
    EMP_TEL = :a_employee.emp_tel :a_emp_tel_ind,
    JOIN_DATE = SYSDATE
  WHERE ENO > :a_employee.eno;
```

[Example 2] The following example shows the use of a structure containing arrays as an output host variable in a SELECT statement.

```
< Sample Program: arrays2.sc >
EXEC SQL BEGIN DECLARE SECTION;
short s_dno;
struct
{
  short dno[5];
  char dname[5][30+1];
```

```
  char dep_location[5][9+1];
  int mgr_no[5];
} a_department2;
EXEC SQL END DECLARE SECTION;

s_dno = 2000;
EXEC SQL SELECT * INTO :a_department2
  FROM DEPARTMENTS WHERE DNO < :s_dno;
```

10.6 Sample Programs

10.6.1 arrays1.sc

This sample can be found at $ALTIBASE_HOME/sample/APRE/arrays1.sc

10.6.2 Result of Execution

```
$ is -f schema/schema.sql
$ make arrays1
$ ./arrays1
<ARRAYS 1>
-----------------------------------------------------
[Scalar Array Host Variables With Insert]
-----------------------------------------------------
3 rows inserted
3 times insert success
-----------------------------------------------------
[Structure Array Host Variables With Insert]
-----------------------------------------------------
3 rows inserted
3 times insert success
-----------------------------------------------------
[Arrays In Structure With Insert]
-----------------------------------------------------
3 rows inserted
3 times insert success
-----------------------------------------------------
[Error Case : Array Host Variables With Insert]
-----------------------------------------------------
SQLCODE : -69720
sqlca.sqlerrm.sqlerrmc : The row already exists in a unique index.
1 rows inserted
1 times insert success
-----------------------------------------------------
[Scalar Array Host Variables With Update]
-----------------------------------------------------
3 rows updated
3 times update success
-----------------------------------------------------
[Arrays In Structure With Update]
-----------------------------------------------------
12 rows updated
3 times update success
-----------------------------------------------------
[Scalar Array Host Variables With Delete]
-----------------------------------------------------
6 rows deleted
3 times delete success
-----------------------------------------------------
[For Clause With Insert]
-----------------------------------------------------
2 rows inserted
2 times insert success
-----------------------------------------------------
[For Clause With Update]
-----------------------------------------------------
2 rows updated
2 times update success
```

```
---------------------------------------------------
[For Clause With Delete]
---------------------------------------------------
3 rows deleted
2 times delete success
```

10.6.3 arrays2.sc

This sample can be found at $ALTIBASE_HOME/sample/APRE/arrays2.sc

10.6.4 Result of Execution

```
$ is -f schema/schema.sql
$ make arrays2
$ ./arrays2
<ARRAYS 2>
---------------------------------------------------
[Scalar Array Host Variables With Select]
---------------------------------------------------
DNO DNAME DEP_LOCATION
---------------------------------------------------
3001 CUSTOMER SUPPORT DEPT London
3002 PRESALES DEPT Peking
4001 MARKETING DEPT Seoul
4002 BUSINESS DEPT Palo Alto
4 rows selected
---------------------------------------------------
[Structure Array Host Variables With Select]
---------------------------------------------------
DNO DNAME DEP_LOCATION MGR_NO
---------------------------------------------------
1001 RESEARCH DEVELOPMENT DEPT 1 New York 16
1002 RESEARCH DEVELOPMENT DEPT 2 Sydney 13
1003 SOLUTION DEVELOPMENT DEPT Osaka 14
3 rows selected
---------------------------------------------------
[Arrays In Structure With Select]
---------------------------------------------------
DNO DNAME DEP_LOCATION MGR_NO
---------------------------------------------------
1001 RESEARCH DEVELOPMENT DEPT 1 New York 16
1002 RESEARCH DEVELOPMENT DEPT 2 Sydney 13
1003 SOLUTION DEVELOPMENT DEPT Osaka 14
3 rows selected
---------------------------------------------------
[Error Case : Array Host Variables]
---------------------------------------------------
Error : [-331880] Too many rows returned
---------------------------------------------------
[Execute Procedure With Array In-Binding]
---------------------------------------------------
Successfully executed procedure
```

11 Dynamic SQL Statements

11.1 Static versus Dynamic SQL Statements

11.1.1 Static SQL Statements

11.1.1.1 Concept

Static SQL statements are those that are defined by the programmer in advance, and are unchangeable.

Static SQL statements are embedded SQL statements that are hard-coded into an application.

For more information about static SQL statements, please refer to Chapter7: Embedded SQL Statements and Chapter9: Using Cursors.

11.1.1.2 Disadvantages

- Static SQL statements cannot be used in applications in which the exact form of the SQL statement cannot be determined in advance.
- The names of tables and columns to be referred to in static SQL statements must be determined by the programmer in advance. In other words, host variables cannot be used in place of table or column names and they cannot be changed.
- Although the use of input host variables with static SQL statements affords a small amount of flexibility, static SQL statements are fundamentally fixed, and cannot be changed in any major way.

11.1.2 Dynamic SQL Statements

11.1.2.1 Concept

The text of dynamic SQL statements is composed in an area of memory (i.e. a character-type variable) set aside for that purpose at run time. Therefore, the SQL statement does not need to be hard-coded in the application source code.

11.1.2.2 Advantages

- The SQL statement to be executed does not need to be predetermined within the program in advance. That is, it becomes possible to use dynamic SQL statements.
- The tables and columns to be accessed can be determined dynamically at run time.

11.1.2.3 Disadvantage

- Because the SQL statement to be executed, as well as the names of the tables and columns to be accessed, are determined only at run time, dynamic SQL statements may be less effective than static SQL statements from the aspect of performance.

11.2 Using Dynamic SQL Statements

Broadly speaking, in ALTIBASE HDB there are three approaches to the implementation of dynamic SQL statements in applications. Each of these approaches can be thought of as a method of executing a series of SQL statements in a prescribed order. The three methods are explained below:

11.2.1 Method 1

This method consists of only one statement: the EXECUTE IMMEDIATE statement.

This method is not suggested for use with frequently executed SQL statements, as it is inefficient and compromises performance.

This method is useful when executing DDL statements for which the entire SQL string is not known until run time.

This method cannot be used to execute SELECT statements.

11.2.1.1 EXECUTE IMMEDIATE

Syntax

```
EXEC SQL EXECUTE IMMEDIATE <:host_var | string_literal>;
```

Arguments

<:*host_var*>: This is a character-type variable that includes all of the SQL statement text.

<*string_literal*>: This is the entire SQL statement, hard-coded in the form of a string.

Description

When using a host variable, only one host variable can be used. This host variable must include all of the SQL statement text. Furthermore, this SQL statement text must not contain any host variables or the question mark (“?”) parameter marker.

Example

[Example 1] The following example shows the use of Method 1 to execute a dynamic SQL statement using a provided SQL statement string.

< Sample Program: dynamic1.sc >

```
EXEC SQL EXECUTE IMMEDIATE DROP TABLE T1;

EXEC SQL EXECUTE IMMEDIATE CREATE TABLE T1 (I1 INTEGER, I2 INTEGER);
```

[Example 2] The following example shows the use of Method 1 to execute a dynamic SQL statement that is stored in a host variable.

< Sample Program: dynamic1.sc >

```
char query[100];
strcpy(query, "drop table t2");
EXEC SQL EXECUTE IMMEDIATE :query;

strcpy(query, "create table t2(i1 integer)");
EXEC SQL EXECUTE IMMEDIATE :query;
```

11.2.2 Method 2

Method 2 consists of two steps: the PREPARE statement and the EXECUTE statement. This method is useful in situations where an SQL statement is prepared once and then executed several times.

The SQL statement string to be used in the PREPARE statement can include the question mark ("?") parameter marker. This parameter marker will be replaced with the value of a host variable in the EXECUTE statement.

The EXECUTE statement will always use the SQL statement in its most recently prepared form, that is, in the form that was prepared by the most recently executed PREPARE statement. This means that any changes to the contents of the prepared SQL statement or to any bound variables since the most recent execution of the PREPARE statement will be ignored by the EXECUTE statement unless the PREPARE statement is executed again.

This method is not efficient in situations in which the text of the SQL statement change frequently, because the need to repeatedly execute the PREPARE and EXECUTE statements will have a negative effect on performance.

This method is useful when executing INSERT, UPDATE, and DELETE statements for which the contents of the SQL statement are determined at run time.

This method cannot be used to execute SELECT statements.

Note: Although not required with Method 2, the DECLARE STATEMENT can be provided before the PREPARE statement. Doing so will not cause an error.

11.2.2.1 PREPARE

Syntax

```
EXEC SQL PREPARE <statement_name> FROM <:host_var | string_literal>;
```

Arguments

<*statement_name*>: This is the identifier of the SQL statement. It must start with an alphabetic character (a ~ z, A ~ Z) or the underscore character ("_"), and must not be longer than 50 bytes.

<:*host_var*>: This is a character-type variable that includes all of the SQL statement text.

<*string_literal*>: This is the entire SQL statement, hard-coded in the form of a string.

Description

This statement is used to prepare an SQL statement for execution.

If the same SQL statement identifier is used in multiple PREPARE statements within the same appli-

cation, then the SQL statement that is executed when the EXECUTE statement is called at run time will be the most recently prepared SQL statement having that identifier.

The SQL statement cannot be a SELECT statement.

Example

In the following example, the text of an SQL statement is determined according to the conditions at run time, and the corresponding SQL statement is then prepared.

< Sample Program: dynamic2.sc >

```
char query[100];

EXEC SQL BEGIN DECLARE SECTION;
   int s_eno;
EXEC SQL END DECLARE SECTION;

if (s_eno < 20)
{
  strcpy(query, "delete from employees where eno = ? and e_lastname = ?");
}
else
{
  strcpy(query, "insert into employees(eno, e_lastname) values (?, ?)");
}

EXEC SQL PREPARE S FROM :query;
```

11.2.2.2 EXECUTE

Syntax

```
EXEC SQL EXECUTE <statement_name> [ USING <host_var_list> ];
```

Arguments

<*statement_name*>: This is the identifier of the SQL statement.

<*host_var_list*>: This is a list of input host variables and input indicator variables

Description

This statement can only be executed after a corresponding PREPARE statement. If an undefined SQL statement identifier is specified when this statement is executed, an error indicating that the SQL statement does not exist will be raised.

The identifier that is specified when this statement is executed cannot be the identifier of a SELECT statement.

The EXECUTE statement is used to execute a previously prepared SQL statement.

When this statement is executed, each parameter marker (“?”) is replaced with a corresponding value. These values are specified as a list of host variables in the USING clause. The number of host variables in the USING clause must be the same as the number of parameter markers in the SQL statement. Furthermore, the type of each host variable must be compatible with the type of the

database column to which it corresponds.

If the same SQL statement identifier is used in multiple PREPARE statements in the same application, then when the EXECUTE statement is called at run time, the most recently prepared SQL statement having that identifier will be executed.

Example

The following example shows the use of the EXECUTE statement.

< Sample Program: dynamic2.sc >

```
EXEC SQL BEGIN DECLARE SECTION;
  int s_eno;
  char s_ename[20+1];
EXEC SQL END DECLARE SECTION;

s_eno = 10;
strcpy(s_ename, "YHBAE");
EXEC SQL EXECUTE S USING :s_eno, :s_ename;
```

11.2.3 Method 3

Method 3 is the only way to use dynamic SQL to execute a SELECT statement, and cannot be used to execute any other kind of statement.

Method 3 consists of the execution of five statements: the PREPARE statement, the DECLARE CURSOR statement, the OPEN statement, the FETCH statement, and the CLOSE statement.

It is possible to rearrange the order of the first two statements so that the DECLARE CURSOR statement precedes the PREPARE statement. In this case, it is necessary to additionally provide the DECLARE STATEMENT statement before the DECLARE CURSOR statement.

11.2.3.1 DECLARE STATEMENT

Syntax

```
EXEC SQL DECLARE <statement_name> STATEMENT;
```

Arguments

<*statement_name*>: This is the identifier of the SQL statement. It must start with an alphabetic character (a ~ z, A ~ Z) or the underscore character (“_”), and must not be longer than 50 bytes.

Description

This statement is used to declare an identifier for an SQL statement to be used in other embedded SQL statements.

This statement is only required if the DECLARE CURSOR statement precedes the PREPARE statement; it is not required if the PREPARE statement precedes the DECLARE CURSOR statement.

Example

In the following example, the DECLARE CURSOR statement precedes the PREPARE statement, and thus the DECLARE STATEMENT is required before the DECLARE CURSOR statement.

```
EXEC SQL DECLARE sql_stmt STATEMENT;
EXEC SQL DECLARE emp_cursor CURSOR FOR sql_stmt;
EXEC SQL PREPARE sql_stmt FROM :dyn_string;
```

11.2.3.2 PREPARE

Syntax

```
EXEC SQL PREPARE <statement_name> FROM
<:host_var | string_literal>;
```

Arguments

<*statement_name*>: This is the identifier of the SQL statement. It can be a maximum of 50 characters.

<:*host_var*>: This is a character-type variable that includes all of the SQL statement text.

<*string_literal*>: This is the entire SQL statement, hard-coded in the form of a string.

Description

This statement is used to prepare an SQL statement for execution.

If the same SQL statement identifier is used in multiple PREPARE statements within the same application, then the SQL statement that is used when the DECLARE CURSOR statement is called at run time will be the most recently prepared SQL statement having that identifier.

The SQL statement must be a SELECT statement.

Example

In the following example, the text of an SQL statement is determined according to the conditions at run time, and the corresponding SQL statement is then prepared.

< Sample Program: dynamic3.sc >

```
char query[100];
int type;
switch (type)
{
case 1:
  strcpy(query, "select * from departments");
  break;
case 2:
  strcpy(query, "select * from goods");
  break;
case 3:
  strcpy(query, "select * from orders");
  break;
}
EXEC SQL PREPARE S FROM :query;
```

11.2.3.3 DECLARE CURSOR

Syntax

```
EXEC SQL DECLARE <cursor_name> CURSOR FOR <statement_name>;
```

Arguments

<*cursor_name*>: This is the name of the cursor.

<*statement_name*>: This is the identifier of the SQL statement.

Description

This statement can be executed after a PREPARE statement, a CLOSE statement, or a CLOSE RELEASE statement. If an undefined SQL statement identifier is specified when the DECLARE CURSOR statement is executed, an error indicating that the SQL statement identifier does not exist will be raised.

The SQL statement identified by the specified SQL statement identifier must be a SELECT statement.

This statement declares a cursor that references the provided SQL statement identifier.

If the same SQL statement identifier is used in multiple PREPARE statements within the same application, then the cursor that is declared will reference the most recently prepared SQL statement having that identifier at run time.

Example

In the following example, the cursor CUR, which references the SQL statement identified by the identifier S, is declared.

< Sample Program: dynamic3.sc >

```
EXEC SQL DECLARE CUR CURSOR FOR S;
```

11.2.3.4 OPEN

Syntax

```
EXEC SQL OPEN <cursor_name> [ USING <host_var_list> ];
```

Arguments

<*cursor_name*>: This is the name of the cursor

<*host_var_list*>: This is a list of output host variables and output indicator variables

Description

The OPEN statement can be executed after the DECLARE CURSOR statement or the CLOSE statement. If an attempt is made to open a cursor that has not been defined, an error indicating that the cursor does not exist will be raised.

The OPEN statement executes the SQL statement that was declared using the DECLARE CURSOR statement.

When this statement is executed, each parameter marker ("?") is replaced with a corresponding value. These values are specified as a list of host variables in the USING clause. The number of host variables in the USING clause must be the same as the number of parameter markers in the SQL statement. Furthermore, the type of each host variable must be compatible with the type of the database column to which it corresponds.

If the same cursor identifier is used in multiple DECLARE CURSOR statements within the same application, then the most recently declared cursor having that identifier at run time will be used.

Limitations

All of the limitations that normally apply to the execution of the SELECT SQL statement in ALTIBASE HDB also apply to the OPEN embedded SQL statement.

Example

The following example shows how to open a cursor called CUR.

< Sample Program: dynamic3.sc >

```
EXEC SQL OPEN CUR;
```

11.2.3.5 FETCH

Syntax

```
EXEC SQL FETCH <cursor_name> INTO <host_var_list>;
```

Arguments

<*cursor_name*>: This is the name of the cursor

<*host_var_list*>: This is a list of output host variables and output indicator variables

Description

The FETCH statement can be executed after the OPEN statement. If an attempt is made to perform a FETCH operation using a cursor that has not been defined, an error indicating that operations are being performed out of sequence will be raised.

This statement is used to return records that were retrieved when the cursor was opened. The host variables into which the records are returned are specified in the host variable list in the INTO clause. Unless a structure-type output host variable is being used, the number of host variables in the INTO clause must be the same as the number of columns in the SELECT clause. Furthermore, the type of each host variable must be compatible with the type of the database column to which it corresponds.

If the same cursor identifier is used in multiple DECLARE CURSOR statements within the same application, then the most recently declared cursor having that identifier at run time will be used.

Example

The following example shows the use of the cursor *CUR* to fetch results into different output host variables depending on the situation. Because an indicator variable has been defined for each host variable, it is possible to handle NULL values. The use of the `while` loop ensures that the FETCH operation is repeated until SQL_NO_DATA is returned.

< Sample Program: dynamic3.sc >

```
int type;

/* declare host variables */
EXEC SQL BEGIN DECLARE SECTION;
  /*declare output host variables */
  department s_department;
  goods s_goods;
  orders s_orders;

  /*declare indicator variables */
  dept_ind s_dept_ind;
  good_ind s_good_ind;
  order_ind s_order_ind;
EXEC SQL END DECLARE SECTION;

while(1)
{
  /* use indicator variables to check for null values */
  switch (type)
  {
  case 1:
    EXEC SQL FETCH CUR
      INTO :s_department :s_dept_ind;
    break;
  case 2:
    EXEC SQL FETCH CUR
      INTO :s_goods :s_good_ind;
    break;
  case 3:
    EXEC SQL FETCH CUR
      INTO :s_orders :s_order_ind;
    break;
  }
  if (sqlca.sqlcode == SQL_SUCCESS)
  {
    cnt++;
  }
  else if (sqlca.sqlcode == SQL_NO_DATA)
  {
    printf("%d rows selected\n\n", cnt);
    break;
  }
  else
  {
    printf("Error : [%d] %s\n\n", SQLCODE, sqlca.sqlerrm.sqlerrmc);
    break;
  }
}
```

11.2.3.6 CLOSE

Syntax

```
EXEC SQL CLOSE <cursor_name>;
```

Arguments

<*cursor_name*>: This is the name of the cursor to close.

Description

The CLOSE statement can be executed after the DECLARE CURSOR statement, the OPEN statement, or the FETCH statement. If an attempt is made to close a cursor that has not been defined, an error indicating that the cursor does not exist will be raised.

If the CLOSE statement is executed when there are still data left to return on the database server (i.e. when not all of the records have been fetched), then the unfetched results will be discarded. However, the resources allocated to the cursor are not freed at this time. Therefore, after the CLOSE statement is executed, the OPEN statement can be executed immediately, without first executing the DECLARE CURSOR statement.

Example

The following example shows the use of the CLOSE statement:

< Sample Program: dynamic3.sc >

```
EXEC SQL CLOSE CUR;
```

11.2.3.7 CLOSE RELEASE

Syntax

```
EXEC SQL CLOSE RELEASE <cursor_name>;
```

Arguments

<*cursor_name*>: This is the name of the cursor.

Description

The CLOSE RELEASE statement can be executed after the DECLARE CURSOR statement, the OPEN statement, the FETCH statement, or the CLOSE statement. If an attempt is made to reference a cursor that has not been defined in the CLOSE RELEASE statement, an error indicating that the cursor does not exist will be raised.

If there are still data left to return on the database server when the CLOSE RELEASE statement is executed, then the unfetched results will be discarded. Additionally, all resources allocated to the cursor will be freed. Therefore, after the CLOSE RELEASE statement has been executed, it will be necessary to execute the DECLARE CURSOR and OPEN statements in sequence. In other words, the OPEN statement cannot be executed after the CLOSE RELEASE statement.

If it is desired to reuse a cursor, execute the CLOSE statement; if not, execute the CLOSE RELEASE statement. In practice, it is not common to use a cursor only once, so the CLOSE RELEASE statement is almost never used. Reusing a cursor name by repeatedly executing the CLOSE RELEASE, DECLARE CURSOR and OPEN statements has a negative impact on performance.

Example

In the following example, the cursor named *CUR* is closed, and all resources allocated to the cursor are freed.

```
EXEC SQL CLOSE RELEASE CUR;
```

11.3 Sample Programs

11.3.1 dynamic1.sc

```
$ALTIBASE_HOME/sample/APRE/dynamic1.sc
```

11.3.2 Result of Execution

```
$ is -f schema/schema.sql
$ make dynamic1
$ ./dynamic1
<DYNAMIC SQL METHOD 1>
----------------------------------------------------
[Using String Literal]
----------------------------------------------------
Success execution with string literal
----------------------------------------------------
[Using Host Variable]
----------------------------------------------------
Success execution with host variable
```

11.3.3 dynamic2.sc

This sample program can be found at $ALTIBASE_HOME/sample/APRE/dynamic2.sc

11.3.4 Result of Execution

```
$ make dynamic2
$ ./dynamic2
<DYNAMIC SQL METHOD 2>
----------------------------------------------------
[Prepare]
----------------------------------------------------
Success prepare
----------------------------------------------------
[Execute]
----------------------------------------------------
Success execute
```

11.3.5 dynamic3.sc

This sample program can be found at $ALTIBASE_HOME/sample/APRE/dynamic3.sc

11.3.6 Result of Execution

```
$ is –f schema/schema.sql
$ make dynamic3
$ ./dynamic3
<DYNAMIC SQL METHOD 3>
----------------------------------------------------
[Prepare]
```

```
---------------------------------------------------
Success prepare
---------------------------------------------------
[Declare Cursor]
---------------------------------------------------
Success declare cursor
---------------------------------------------------
[Open Cursor]
---------------------------------------------------
Success open cursor
---------------------------------------------------
[Fetch Cursor]
---------------------------------------------------
30 rows selected
---------------------------------------------------
[Close Cursor]
---------------------------------------------------
Success close cursor
```

12 Using Stored Procedures in C/C++

12.1 Using Stored Procedures

Embedded SQL statements can be used to create and execute stored procedures and stored functions within applications.

12.1.1 CREATE

This statement is used to create a stored procedure or stored function.

12.1.1.1 Syntax

Stored procedure

```
EXEC SQL CREATE [ OR REPLACE ] PROCEDURE
<procedure_name> [ ( [ <parameter_declaration_list> ] ) ]
AS | IS
[ <declaration_section> ]
BEGIN <statement>
[ EXCEPTION <exception_handler> ]
END
[ <procedure_name> ] ;
END-EXEC;
```

Stored function

```
EXEC SQL CREATE [ OR REPLACE ] FUNCTION
<function_name> [ ( [ <parameter_declaration_list> ] ) ]
RETURN <data_type>
AS | IS
[ <declaration_section> ]
BEGIN <statement>
[ EXCEPTION <exception_handler> ]
END
[ <function_name> ] ;
END-EXEC;
```

12.1.1.2 Arguments

<procedure_name>: This is the name of the stored procedure.

<function_name>: This is the name of the stored function.

<parameter_declaration_list>: Please refer to the *Stored Procedures Manual*.

<declaration_section>: Please refer to the *Stored Procedures Manual*.

<statement>: Please refer to the *Stored Procedures Manual*.

<exception_handler>: Please refer to the *Stored Procedures Manual*.

<data_type>: Please refer to the *Stored Procedures Manual*.

12.1.1.3 Examples

Various examples in which stored procedures and stored functions are created are shown below.

[Example 1] The following example illustrates the creation of a stored procedure.

In this example, the stored procedure ORDER_PROC is created. This procedure searches for one record in which the value in the ONO column is the same as the value of the *s_ono* parameter of the stored procedure. If no records are found, then a new record having default values is inserted into the ORDERS table. If one record is found, then the values in the PROCESSING column in the record that is found are written to 'P'.

```
< Sample Program: psm1.sc >
EXEC SQL CREATE OR REPLACE PROCEDURE ORDER_PROC
 (s_ono in bigint)
AS
  p_order_date date;
  p_eno integer;
  p_cno bigint;
  p_gno char(10);
  p_qty integer;
BEGIN
  SELECT ORDER_DATE, ENO, CNO, GNO, QTY
    INTO p_order_date, p_eno, p_cno, p_gno, p_qty
    FROM ORDERS
    WHERE ONO = s_ono;
EXCEPTION
WHEN NO_DATA_FOUND THEN
  p_order_date := SYSDATE;
  p_eno := 13;
  p_cno := BIGINT'7610011000001';
  p_gno := 'E111100013';
  p_qty := 4580;
  INSERT INTO ORDERS (ONO, ORDER_DATE, ENO, CNO, GNO, QTY)
    VALUES (s_ono, p_order_date, p_eno, p_cno, p_gno, p_qty);
WHEN TOO_MANY_ROWS THEN
  NULL;
WHEN OTHERS THEN
  UPDATE ORDERS
    SET PROCESSING = 'P'
    WHERE ONO = s_ono;
END;
END-EXEC;
```

[Example 2] The following example illustrates the creation of a stored function.

This stored function inserts a new record into the ORDERS table, and then counts and returns the number of records in the ORDERS table.

< Sample Program: psm2.sc >

```
EXEC SQL CREATE OR REPLACE FUNCTION ORDER_FUNC(
  s_ono in bigint, s_order_date in date,
  s_eno in integer, s_cno in char(13),
  s_gno in char(10), s_qty in integer)
RETURN INTEGER
AS
  p_cnt integer;
BEGIN
  INSERT INTO ORDERS (ONO, ORDER_DATE, ENO, CNO, GNO, QTY)
    VALUES(s_ono, s_order_date, s_eno, s_cno, s_gno, s_qty);

  SELECT COUNT(*) INTO p_cnt
    FROM ORDERS;

  RETURN p_cnt;
END;
```

```
END-EXEC;
```

12.1.2 ALTER

This statement is used to precompile a stored procedure or stored function.

12.1.2.1 Syntax

Stored procedure

```
EXEC SQL ALTER PROCEDURE <procedure_name> COMPILE;
```

Stored function

```
EXEC SQL ALTER FUNCTION <function_name> COMPILE;
```

12.1.2.2 Argument

<procedure_name>: This is the name of the stored procedure.

<function_name>: This is the name of the stored function.

12.1.2.3 Description

This statement is used to recompile a currently invalid stored procedure or stored function to restore it to a valid state.

12.1.2.4 Examples

Two examples in which stored procedures and stored functions are recompiled are shown below.

[Example 1] In the following example, the stored procedure *ORDER_PROD* is recompiled.

```
EXEC SQL ALTER PROCEDURE ORDER_PROC COMPILE;
```

[Example 2] In the following example, the stored function ORDER_FUNC is recompiled.

```
EXEC SQL ALTER FUNCTION ORDER_FUNC COMPILE;
```

12.1.3 DROP

This statement is used to delete the stored procedure or stored function.

12.1.3.1 Syntax

Stored procedure

```
EXEC SQL DROP PROCEDURE <procedure_name>;
```

Stored function

```
EXEC SQL DROP FUNCTION <function_name>;
```

12.1.3.2 Argument

<procedure_name>: This is the name of the stored procedure.

<function_name>: This is the name of the stored function.

12.1.3.3 Examples

Two examples in which stored procedures and stored functions are dropped are shown below.

[Example 1] In the following example, the stored procedure ORDER_PROC is dropped.

```
< Sample Program: psm1.sc >
EXEC SQL DROP PROCEDURE ORDER_PROC;
```

[Example 2] In the following example, the stored function ORDER_FUNC is dropped.

```
< Sample Program: psm2.sc >
EXEC SQL DROP FUNCTION ORDER_FUNC;
```

12.1.4 EXECUTE

This statement is used to execute a stored procedure or stored function.

12.1.4.1 Syntax

Stored procedure

```
EXEC SQL EXECUTE BEGIN
<procedure_name>
[ ( [ <:host_var> [ IN | OUT | IN OUT ] [ , … ] ] ) ];
END;
END-EXEC;
```

Stored function

```
EXEC SQL EXECUTE BEGIN
<:host_var> := <function_name>
[ ( [ <:host_var> [ IN | OUT | IN OUT ] [ , … ] ] ) ];
END;
END-EXEC;
```

12.1.4.2 Argument

<procedure_name>: This is the name of the stored procedure.

<function_name>: This is the name of the stored function.

<:host_var>: This is used to specify any IN, OUT or IN/OUT parameters (i.e. input or output host variables) that are necessary for the execution of the stored procedure or function, as well as any output host variables for storing the result of the stored function.

12.1.4.3 Examples

Examples of the execution of stored procedures and stored functions are shown below.

[Example 1] In the following example, the stored procedure ORDER_PROC is executed.

< Sample Program: psm1.sc >

```
EXEC SQL BEGIN DECLARE SECTION;
  long long s_ono;
EXEC SQL END DECLARE SECTION;

s_ono = 111111;
EXEC SQL EXECUTE
BEGIN
  ORDER_PROC(:s_ono in);
END;
END-EXEC;
```

[Example 2] In the following example, the stored function ORDER_FUNC is executed.

< Sample Program: psm2.sc >

```
EXEC SQL BEGIN DECLARE SECTION;
long long s_ono;
char s_order_date[19+1];
int s_eno;
char s_cno[13+1];
char s_gno[10+1];
int s_qty;
int s_cnt;
EXEC SQL END DECLARE SECTION;
s_ono = 200000001;
s_eno = 20;
s_qty = 2300;
strcpy(s_order_date, "19-May-03");
strcpy(s_cno, "7111111431202");
strcpy(s_gno, "C111100001");
EXEC SQL EXECUTE
BEGIN
 :s_cnt := ORDER_FUNC(:s_ono in, :s_order_date in,
 :s_eno in, :s_cno in,
:s_gno in, :s_qty in);
END;
END-EXEC;
```

12.2 Using Array-Type Host Variables with the EXECUTE Statement

Array-type host variables can be used with the EXECUTE statement. When array-type host variables are used with the EXECUTE statement, executing the EXECUTE statement a single time has the same effect as executing the EXECUTE statement a number of time equal to the size of the array, thereby realizing a performance improvement.

12.2.1 Array Types

When used with the EXECUTE statement, array-type host variables can only be used as IN parameters. That is, they cannot be used as IN/OUT or OUT parameters.

The following shows the array types that can be used in the EXECUTE statement:

- Simple arrays
- Structures containing arrays as elements thereof

12.2.2 Limitations

The use of array-type host variables with the EXECUTE statement is limited in the following ways. Please keep them in mind when writing applications.

- Array-type host variables cannot be used as OUT or IN/OUT parameters.

```
Example)
EXEC SQL BEGIN DECLARE SECTION;
  int var1[10];
  int var2[10];
  int var3[10];
EXEC SQL END DECLARE SECTION;

EXEC SQL EXECUTE BEGIN
PROC1(:var1 in, :var2 out, :var3 in out); // not acceptable
END;
END-EXEC;
```

- The value returned by a stored function cannot be assigned to an array-type host variable.

```
Example)
EXEC SQL BEGIN DECLARE SECTION;
  int var1[10];
  int var2[10];
  int var3[10];
EXEC SQL END DECLARE SECTION;

EXEC SQL EXECUTE BEGIN
:var1 = FUNC1(:var2 in, :var3 in); // not acceptable
END;
END-EXEC;
```

- Array-type host variables cannot be used together with non-array type host variables as parameters for stored procedures or functions.

```
Example)
EXEC SQL BEGIN DECLARE SECTION;
  int var1;
  int var2;
  int var3[10];
EXEC SQL END DECLARE SECTION;

EXEC SQL EXECUTE BEGIN
PROC1(:var1 in, :var2 in, :var3 in); // not acceptable
END;
END-EXEC;
```

Due to the last two limitations above, array-type host variables cannot be used in stored function execution statements.

12.2.3 Example

The following example shows the use of array-type host variables as IN parameters in a stored procedure execution statement.

< Sample Program: arrays2.sc >

```
EXEC SQL BEGIN DECLARE SECTION;
  char a_gno[3][10+1];
  char a_gname[3][20+1];
EXEC SQL END DECLARE SECTION;

strcpy(a_gno[0], "G111100001");
strcpy(a_gno[1], "G111100002");
strcpy(a_gno[2], "G111100003");
strcpy(a_gname[0], "AG-100");
strcpy(a_gname[1], "AG-200");
strcpy(a_gname[2], "AG-300");
EXEC SQL EXECUTE
BEGIN
  GOODS_PROC(:a_gno in, :a_gname in);
END;
END-EXEC;
```

12.3 Sample Programs

12.3.1 psm1.sc

This sample program can be found at $ALTIBASE_HOME/sample/APRE/psm1.sc

12.3.1.1 Result of Execution

```
$ is -f schema/schema.sql
$ make psm1
$ ./psm1
<SQL/PSM 1>
-----------------------------------------------------
[Create Procedure]
-----------------------------------------------------
Success create procedure
-----------------------------------------------------
[Execute Procedure]
-----------------------------------------------------
Success execute procedure
-----------------------------------------------------
[Drop Procedure]
-----------------------------------------------------
Success drop procedure
```

12.3.2 psm2.sc

This sample program can be found at $ALTIBASE_HOME/sample/APRE/psm2.sc

12.3.2.1 Result of Execution

```
$ is -f schema/schema.sql
$ make psm2
$ ./psm2
<SQL/PSM 2>
-----------------------------------------------------
[Create Function]
-----------------------------------------------------
Success create function
-----------------------------------------------------
[Execute Function]
-----------------------------------------------------
31 rows selected
-----------------------------------------------------
[Drop Function]
-----------------------------------------------------
Success drop function
```

13 Applications with Multiple Database Connections

13.1 Overview

APRE supports the authoring of applications that establish more than one database connection. This chapter describes multiple connections and explains how to establish and maintain them.

13.1.1 The Need for Multiple Connections

Here are some of the circumstances in which it might be desirable to implement multiple database connections within a single application:

- When it is necessary to access multiple database servers from the same application
- When multiple users need to access a database server using the same application
- In multi-threaded applications. For more information about multi-threaded applications, please refer to Chapter14: Multithreaded Applications.

13.1.2 Connection Name

In an application with multiple database connections, the connections are distinguished from one another using the connection names. The name of each connection must be unique within the application. Only one connection that does not have a connection name can exist within an application. This connection is called the “default connection”.

The name of each connection is set when the connection with a database server is established. To use this connection in subsequently executed embedded SQL statements, the connection name must be specified. If an attempt is made to establish a connection using the name of a connection that has already been established, an error will be raised, indicating that an established connection with that name already exists.

Each connection name must start with an alphabetic character (a ~ z, A ~ Z) or the underscore character (“_”), and must not be longer than 50 bytes.

13.1.2.1 Syntax

To specify a desired connection when executing an embedded SQL statement, use the AT option, as shown below:

```
EXEC SQL [ AT <conn_name | :conn_name> ] …
```

13.1.2.2 Arguments

Both hard-coded strings and host variables can be used to specify the connection name. If using a host variable, it does not need to be declared in the host variable declaration section.

<*conn_name*>: This is the name of the connection in the form of a string literal.

<:*conn_name*>: This is the name of the connection, stored in a host variable.

13.1.3 Steps for Authoring a Multiple-Connection Application

The process of authoring an application that uses multiple database connections is not much different from the process of authoring an application that uses only one database connection. The steps to follow when writing an application with multiple database connections are as follows:

1. Establish a connection to the database server. The name of the connection is defined at this time.

2. Execute embedded SQL statements using the name of the established connection.

3. Terminate the established connection.

The above steps must be followed for each respective connection that is established.

13.2 SQL Statements for Multi-Connections

The method of using embedded SQL statements in applications with multiple database connections is not very different from when using embedded SQL statements in other applications. The basic syntax of each command is the same; all that is additionally required is to specify the name of the connection using the AT clause. The following describes how to use embedded SQL statements in applications with multiple database connections.

13.2.1 CONNECT

This statement is used to establish a connection to the database server and define a name for the connection.

13.2.1.1 Syntax

```
EXEC SQL [ AT <conn_name | :conn_name> ]
CONNECT <:user> IDENTIFIED BY <:passwd>
[ USING <:conn_opt1> [ , <:conn_opt2> ] ];
```

13.2.1.2 Arguments

<*conn_name*>: This is the name to use for the connection in the form of a string literal.

<:*conn_name*>: This is the name to use for the connection, stored in a host variable.

<:*user*>: This is the name of the user with which to connect to the database server.

<:*passwd*>: This is the password for the user with which the connection to the database server is established.

<:*conn_opt1*>: Please refer to Chapter7: Embedded SQL Statements.

<:*conn_opt2*>: Please refer to Chapter7: Embedded SQL Statements.

13.2.1.3 Description

When establishing more than one connection in one application, it is necessary to specify a name for every connection except the default connection. The name of each connection must be unique within the application. After the connection has been established, the name of the connection to use in subsequently executed embedded SQL statements must be specified using the AT clause.

13.2.1.4 Considerations

- In an application with multiple database connections, only one connection that does not have a name is allowed. If no connection name is specified in subsequently executed embedded SQL statements, they will be processed using this connection (the default connection).
- If an attempt is made to establish a connection using the name of an established connection, an error will be raised, indicating that an established connection with that name already exists. To establish a new connection using the same name as an existing connection, it is first necessary to execute the FREE or DISCONNECT statement. If the database server is online, execute

the DISCONNECT statement, whereas if the database server is offline, execute the FREE statement.

13.2.1.5 Examples

The following two examples illustrate how to specify the name of a connection when establishing a connection.

[Example 1] In the following example, a connection is established with a database server, and the connection is identified using the provided string literal. Thus, “CONN1” is the name of the established connection.

```
< Sample Program: mc1.sc >
EXEC SQL BEGIN DECLARE SECTION;
  char usr[10];
  char pwd[10];
EXEC SQL END DECLARE SECTION;

/* set username */
strcpy(usr, "SYS");
/* set password */
strcpy(pwd, "MANAGER");

/* connect to ALTIBASE server with CONN1 */
EXEC SQL AT CONN1 CONNECT :usr IDENTIFIED BY :pwd;
```

[Example 2] In this example, a connection is established with a database server, and the connection is identified using the value of the host variable. Thus, “CONN2” is the name of the established connection.

```
< Sample Program: mc2.sc >
char usr[10];
char pwd[10];
char conn_name2[10];

/* set username */
strcpy(usr, "ALTITEST");
/* set password */
strcpy(pwd, "ALTITEST");
/* set connname */
strcpy(conn_name2, "CONN2");

/* connect to ALTIBASE server with :conn_name2 */
EXEC SQL AT :conn_name2 CONNECT :usr IDENTIFIED BY :pwd;
```

13.2.2 DISCONNECT

This statement is used to terminate the database server connection identified by the specified connection name.

13.2.2.1 Syntax

```
EXEC SQL [ AT <conn_name | :conn_name> ] DISCONNECT;
```

13.2.2.2 Arguments

<*conn_name*>: This is the name of the connection to terminate in the form of a string literal.

<:*conn_name*>: This is the name of the connection to terminate, stored in a host variable.

13.2.2.3 Considerations

The connection name, if specified, must be the name of a valid connection, that is, a connection that has already been established.

In an application in which multiple database connections have been established, it will be necessary to specify the name of each connection, except for the default connection, when terminating the connection.

13.2.2.4 Examples

The following two examples illustrate how to terminate a connection.

[Example 1] In the following example, a connection with a database server, identified using a string literal, is terminated. The name of the connection to be terminated is "CONN1".

```
< Sample Program: mc1.sc >
EXEC SQL AT CONN1 DISCONNECT;
```

[Example 2] In the following example, a connection with a database server, identified using a host variable, is terminated. The name of the connection to be terminated is "CONN2".

```
< Sample Program: mc2.sc >
char conn_name2[10];
strcpy(conn_name2, "CONN2");
EXEC SQL AT :conn_name2 DISCONNECT;
```

13.2.3 Executing Basic SQL Statements

The method of specifying the connection when executing DML statements such as SELECT and UPDATE and DDL statements such as CREATE and DROP is explained in this section.

13.2.3.1 Syntax

```
EXEC SQL [ AT <conn_name | :conn_name> ]
[ SELECT | UPDATE | INSERT | DELETE |CREATE ] …
```

13.2.3.2 Arguments

<*conn_name*>: This is the name of the connection in the form of a string literal.

<:*conn_name*>: This is the name of the connection, stored in a host) variable.

13.2.3.3 Consideration

The connection name, if specified, must be the name of a valid connection, that is, a connection that

has already been established.

13.2.4 Cursor Statements

The method of specifying the connection when executing cursor-related embedded SQL statements is explained in this section.

13.2.4.1 Syntax

```
EXEC SQL [ AT <conn_name | :conn_name> ]
[ DELCARE | OPEN | FETCH | CLOSE ] <cursor_name> …
```

13.2.4.2 Arguments

<*conn_name*>: This is the name of the connection in the form of a string literal.

<:conn_name>: This is the name of the connection, stored in a host variable.

<*cursor_name*>: Cursor name

13.2.4.3 Consideration

The connection name, if specified, must be the name of a valid connection, that is, a connection that has already been established.

13.2.5 Dynamic SQL Statements

The method of specifying the connection when executing dynamic SQL statements is explained in this section.

13.2.5.1 Syntax

- Method 1

  ```
  EXEC SQL [ AT <conn_name | :conn_name> ] EXECUTE IMMEDIATE …
  ```

- Method 2

  ```
  EXEC SQL [ AT <conn_name | :conn_name> ] PREPARE …
  ```

  ```
  EXEC SQL [ AT <conn_name | :conn_name> ] EXECUTE …
  ```

- Method 3

  ```
  EXEC SQL [ AT <conn_name | :conn_name> ] PREPARE …
  ```

  ```
  EXEC SQL [ AT <conn_name | :conn_name> ] DECLARE …
  ```

  ```
  EXEC SQL [ AT <conn_name | :conn_name> ] OPEN …
  ```

  ```
  EXEC SQL [ AT <conn_name | :conn_name> ] FETCH …
  ```

```
EXEC SQL [ AT <conn_name | :conn_name> ] CLOSE …
```

13.2.5.2 Arguments

<*conn_name*>: This is the name of the connection in the form of a string literal.

<:*conn_name*>: This is the name of the connection, stored in a host variable.

13.2.5.3 Consideration

The connection name, if specified, must be the name of a valid connection, that is, a connection that has already been established.

13.2.6 Other SQL statements

The method of specifying the connection when executing other SQL statements, such as those for setting the autocommit mode and committing and rolling back transactions, is explained in this section.

13.2.6.1 Syntax

```
EXEC SQL [ AT <conn_name | :conn_name> ]
  AUTOCOMMIT { ON | OFF };

EXEC SQL [ AT <conn_name | :conn_name> ]
  COMMIT;

EXEC SQL [ AT <conn_name | :conn_name> ]
  SAVEPOINT <savepoint_name>;

EXEC SQL [ AT <conn_name | :conn_name> ]
  ROLLBACK [ TO SAVEPOINT <savepoint_name> ];

EXEC SQL [ AT <conn_name | :conn_name> ]
  FREE;

EXEC SQL [ AT <conn_name | :conn_name> ]
  BATCH;
```

13.2.6.2 Arguments

<*conn_name*>: This is the name of the connection in the form of a string literal.

<:*conn_name*>: This is the name of the connection, stored in a host variable.

<*savepoint_name*>: This is the name of a savepoint.

13.2.6.3 Consideration

The connection name, if specified, must be the name of a valid connection, that is, a connection that has already been established.

13.2.7 Exceptions

The AT clause is never used with the following embedded SQL statements, even in applications in which multiple database connections have been established:

13.2.7.1 Syntax

```
EXEC SQL INCLUDE …

EXEC SQL OPTION …

EXEX SQL WHENEVER …
```

13.3 Using Stored Procedures in Multiple-Connection Applications

SQL statements for managing stored procedures can also be used in applications with multiple database connections. The syntax for these statements is the same as was described in Chapter12: Using Stored Procedures in C/C++, with the exception that the AT clause is additionally provided.

13.3.1 CREATE

This statement is used to create a stored procedure or stored function in an application with multiple active database connections.

13.3.1.1 Syntax

```
EXEC SQL [ AT <conn_name | :conn_name> ]
 CREATE [ OR REPLACE ] <PROCEDURE | FUNCTION>
 …
 END
 [ <procedure_name | function_name> ] ;
END-EXEC;
```

13.3.1.2 Arguments

<*conn_name*>: This is the name of the connection in the form of a string literal.

<:*conn_name*>: This is the name of the connection, stored in a host variable.

<*procedure_name*>: This is the name of the stored procedure to create.

<*function_name*>: This is the name of the stored function to create.

13.3.1.3 Consideration

The connection name, if specified, must be the name of a valid connection, that is, a connection that has already been established.

13.3.2 ALTER

This statement is used to recompile a stored procedure or stored function in an application with multiple active database connections.

13.3.2.1 Syntax

```
EXEC SQL [ AT <conn_name | :conn_name> ]
 ALTER PROCEDURE <procedure_name | function_name> COMPILE;
```

13.3.2.2 Arguments

<*conn_name*>: This is the name of the connection in the form of a string literal.

<:*conn_name*>: This is the name of the connection, stored in a host variable.

<*procedure_name*>: This is the name of the stored procedure to recompile.

<*function_name*>: This is the name of the stored function to recompile.

13.3.2.3 Consideration

The connection name, if specified, must be the name of a valid connection, that is, a connection that has already been established.

13.3.3 DROP

This statement is used to drop a stored procedure or stored function in an application with multiple active database connections.

13.3.3.1 Syntax

```
EXEC SQL [ AT <conn_name | :conn_name> ]
 DROP PROCEDURE <procedure_name | function_name>;
```

13.3.3.2 Arguments

<*conn_name*>: This is the name of the connection in the form of a string literal.

<:*conn_name*>: This is the name of the connection, stored in a host variable.

<*procedure_name*>: This is the name of the stored procedure to drop.

<*function_name*>: This is the name of the stored function to drop.

13.3.3.3 Consideration

The connection name, if specified, must be the name of a valid connection, that is, a connection that has already been established.

13.3.4 EXECUTE

This statement is used to execute a stored procedure or stored function in an application with multiple active database connections.

13.3.4.1 Syntax

```
EXEC SQL [ AT <conn_name | :conn_name> ]
 EXECUTE BEGIN
 /* stored procedure block here */
```

```
 END;
END-EXEC;
```

13.3.4.2 Arguments

<*conn_name*>: This is the name of the connection in the form of a string literal.

<:*conn_name*>: This is the name of the connection, stored in a host variable.

<*procedure_name*>: This is the name of the stored procedure to execute.

<*function_name*>: This is the name of the stored function to execute.

/* Stored procedure block here */: Please refer to the *Stored Procedures Manual*

13.3.4.3 Consideration

The connection name, if specified, must be the name of a valid connection, that is, a connection that has already been established.

13.4 Sample Programs

13.4.1 mc1.sc

This sample application can be found at $ALTIBASE_HOME/sample/APRE/mc1.sc

13.4.1.1 Result of Execution

```
$ is -f schema/schema.sql
$ make mc1
$ ./mc1
<MULTI CONNECTION 1>
-----------------------------------------------------
[Declare Cursor With CONN1 ]
-----------------------------------------------------
Success declare cursor with CONN1
-----------------------------------------------------
[Open Cursor With CONN1]
-----------------------------------------------------
Success open cursor with CONN1
-----------------------------------------------------
[Fetch Cursor With CONN1 -> Insert With CONN2]
-----------------------------------------------------
30 rows inserted
-----------------------------------------------------
[Close Cursor With CONN1]
-----------------------------------------------------
Success close cursor with CONN1
```

13.4.2 mc2.sc

This sample application can be found at $ALTIBASE_HOME/sample/APRE/mc2.sc

13.4.2.1 Result of Execution

```
$ is -f schema/schema.sql
$ make mc2
$ ./mc2
<MULTI CONNECTION 2>
-----------------------------------------------------
[Dynamic SQL Method 1 With :conn_name2]
-----------------------------------------------------
Success dynamic sql method 1 with :conn_name2
-----------------------------------------------------
[Dynamic SQL Method 2 (PREPARE) With :conn_name2]
-----------------------------------------------------
Success dynamic sql method 2 (prepare) with :conn_name2
-----------------------------------------------------
[Dynamic SQL Method 3 (PREPARE) With :conn_name1]
-----------------------------------------------------
Success dynamic sql method 3 (prepare) with :conn_name1
-----------------------------------------------------
[Dynamic SQL Method 3 (DECLARE CURSOR) With :conn_name1]
-----------------------------------------------------
Success dynamic sql method 3 (declare cursor) with :conn_name1
-----------------------------------------------------
```

```
[Dynamic SQL Method 3 (OPEN CURSOR) With :conn_name1]
----------------------------------------------------
Success dynamic sql method 3 (open cursor) with :conn_name1
----------------------------------------------------
[Dynamic SQL Method 3 (FETCH CURSOR) With :conn_name1
 -> Dynamic SQL Method 2 (EXECUTE-INSERT) With :conn_name2]
----------------------------------------------------
20 rows inserted
----------------------------------------------------
[Dynamic SQL Method 3 (CLOSE CURSOR) With :conn_name1]
----------------------------------------------------
Success dynamic sql method 3 (close cursor) with :conn_name1
```

13.4.3 mc3.sc

This sample application can be found at $ALTIBASE_HOME/sample/APRE/mc3.sc

13.4.3.1 Result of Execution

```
$ is -f schema/schema.sql
$ make mc3
$ ./mc3
<MULTI CONNECTION 3>
----------------------------------------------------
[Autocommit Off With CONN1]
----------------------------------------------------
Autocommit mode of CONN1 session modified false
----------------------------------------------------
[Autocommit Off With CONN2]
----------------------------------------------------
Autocommit mode of CONN2 session modified false
----------------------------------------------------
[Create Procedure With CONN1]
----------------------------------------------------
Success create procedure
----------------------------------------------------
[Create Procedure With CONN2]
----------------------------------------------------
Success create procedure
----------------------------------------------------
[Execute Procedure With CONN1]
----------------------------------------------------
Success execute procedure
----------------------------------------------------
[Execute Procedure With CONN2]
----------------------------------------------------
Success execute procedure
----------------------------------------------------
[Commit With CONN1]
----------------------------------------------------
Success commit
----------------------------------------------------
[Commit With CONN2]
----------------------------------------------------
Success commit
----------------------------------------------------
[Drop Procedure With CONN1]
----------------------------------------------------
Success drop procedure
-----------------------------------------------------------
[Drop Procedure With CONN2]
```

```
-----------------------------------------------------
Success drop procedure
```

14 Multithreaded Applications

14.1 Multithreaded Applications

APRE can be used to author multi-threaded applications. This chapter explains how to use embedded SQL statements in multi-threaded programs, and highlights some considerations to keep in mind when doing so.

14.1.1 Configuring an Application as a Multithreaded Application

When precompiling a multithreaded application, APRE needs to be informed that the application is a multithreaded application. This can be accomplished in either of the following two ways:

- By setting the `-mt` option on the command line:

  [Example]

  ```
  $ apre -mt sample1.sc
  ```

- Using the OPTION statement in the file to be precompiled:

  [Example]

  ```
  EXEC SQL OPTION (THREADS = TRUE);
  ```

14.1.2 Description

- Each thread must have its own database connection. In other words, it is impossible for multiple threads to share a single database connection.
- The name of each connection must be unique within the application. If an attempt is made to establish a connection using the name of an established connection, an error will be raised, indicating that an established connection with that name already exists.
- Only one connection that does not have a name (i.e. the default connection) is allowed.
- The name of the connection to use must be specified within each embedded SQL statement. For more information about the use of connection names, please refer to Chapter13: Applications with Multiple Database Connections.

Note: In previous versions of APRE (i.e. SESC versions 3.5.5 and earlier), it was necessary to use the EXEC SQL THREADS statement in all functions that contained embedded SQL statements and were intended for use in a multithreaded environment. In versions subsequent to version 3.5.5, this is not necessary, but there is no need to remove the EXEC SQL THREADS command from existing programs as its presence does not cause any compatibility problems.

14.2 Sample Programs

14.2.1 mt1.sc

This sample can be found at $ALTIBASE_HOME/sample/APRE/mt1.sc

14.2.1.1 Result of Execution

```
$ is -f schema/schema.sql
$ make mt1
$ ./mt1
<MULTI THREADS 1>
```

14.2.2 mt2.sc

This sample can be found at $ALTIBASE_HOME/sample/APRE/mt2.sc

14.2.2.1 Result of Execution

```
$ is -f schema/schema.sql
$ make mt2
$ ./mt2
<MULTI THREADS 2>
-----------------------------------------------------
ORDER_DATE ENO GNO
-----------------------------------------------------
2000/11/29 00:00:00 12 A111100002
2000/11/29 00:00:00 12 E111100001
2000/11/29 00:00:00 19 E111100001
2000/12/10 00:00:00 19 D111100008
2000/12/01 00:00:00 19 D111100004
2000/12/29 00:00:00 12 C111100001
2000/12/29 00:00:00 20 E111100002
2000/12/30 00:00:00 20 D111100002
2000/12/30 00:00:00 19 D111100008
2000/12/30 00:00:00 20 A111100002
2000/12/30 00:00:00 12 D111100002
2000/12/30 00:00:00 20 D111100011
2000/12/30 00:00:00 20 D111100003
2000/12/30 00:00:00 19 D111100010
2000/12/30 00:00:00 20 C111100001
2000/12/30 00:00:00 12 E111100012
2000/12/30 00:00:00 20 C111100001
2000/12/30 00:00:00 12 F111100001
```

15 Error Codes and Messages

15.1 Precompiler Errors

The messages for the errors that can be raised during the precompile operation have the following format:

15.1.1 Error Format

```
[ERR-<error code> : <error message>]
File  : <file name>
Line  : <line number>
Offset: <n-m>
Error_token:<error statement>
```

<error code>: This is the numerical code corresponding to the error that occurred.

<error message>: This is the corresponding error message.

<file name>: This is the name of the file containing the code that caused the error.

<line number>: This is the number of the line in which the error occurred.

<n-m>: This is the start and end character indicating the portion of the line in which the error occurred.

<error statement>: This is the kind of statement that caused the error.

15.1.1.1 Example

The following example shows the error that is raised when the EXEC SQL END DECLARE SECTION statement is missing from the source code.

```
[ERR-302L : EXEC SQL END DECLARE SECTION does not exist.]
File : tmp.sc
Line : 4
Offset: 1-31
Error_token:EXEC SQL BEGIN DECLARE SECTION;
```

15.1.2 Error Code Format

```
ERR-xxxY
```

xxx: This is the error number.

Y: This is a single alphabetic character that indicates the error category (see below).

15.1.2.1 Error Numbers

The error numbers fall within certain ranges that indicate the kind of error that occurred. These ranges are as follows:

101 – 199: These are system errors.

201 – 299: These are errors related to host variables.

301 – 399: These are cursor-related errors.

401 – 499: These are general errors.

701 – 799: These are errors related to the lack of support for some functionality in the current version.

15.1.2.2 Error Categories

These error categories indicate the precompiling task that was underway when the error occurred.

E: This indicates that the error occurred while processing the host variable declaration section.

L: This indicates that the error occurred while processing an embedded SQL statement.

M: This indicates that the error occurred while performing macro substitutions.

H: This indicates that the error occurred when performing a task other than those listed above.

15.1.3 Error Codes/Messages List

15.1.3.1 101H – 199H

Error Code	Error Message
101H	File '<file name>' open error.
102H	FileSize(<file name>) is zero.
103H	The include file [<file name>] does not exist in the folder.
104H	File '<file name>' delete error.
105H	Memory allocation error.
106H	Latch initialize error. (<file name>:<line>)
107H	Latch read error. (<file name>:<line>)
108H	Latch release error. (<file name>:<line>)
109H	Latch write error. (<file name>:<line>)
110H	Latch destroy error. (<file name>:<line>)
111H	File close error.
112H	File <file name> write error.

15.1.3.2 201E – 299E

Error Code	Error Message
201E	C-type comment is not closed.
202E	The structure name [<name>] is unknown.
203E	The structure name [<name>] is a duplicate.
204E	The symbol name [<name>] cannot be added to the symbol table.
205E	The symbol name exceeds the maximum length. [<name>]
206E	Redefinition of '<name>'.
207E	Unknown type '<name>'.
208E	Invalid scope depth [<depth>].
209E	Inconsistent brace count.
210E	Inconsistent parenthesis count error.
211E	The nested structure exceeds the maximum possible depth.
212E	VARCHAR declarations are not permitted in #include files.

15.1.3.3 301L – 399L

Error Code	Error Message
301L	The C include file can't contain embedded SQL statements.
302L	EXEC SQL END DECLARE SECTION does not exist.
303L	EXEC SQL BEGIN DECLARE SECTION does not exist.
304L	EXEC SQL END ARGUMENT SECTION does not exist.
305L	EXEC SQL BEGIN ARGUMENT SECTION does not exist.
306L	Unterminated string error.
307L	The connection name [<name>] is too long. (max length is 50)
308L	The cursor name [<name>] is too long. (max length is 50)
309L	Statement name [<name>] is too long. (max length is 50)
310L	The number of FOR loop iterations must be greater than zero.
311L	The host variable [<name>] is unknown.
312L	The host variable in a FREE LOB statement must be a LOB locator.
313L	Unterminated embedded SQL statement.

Error Code	Error Message
314L	The indicator variable [<name>] should be of type SQLLEN or a compatible type.
315L	Two or more arrays of structures are bound to host variables in the same statement.

15.1.3.4 401M – 499M

Error Code	Error Message
401M	An unknown macro is too long. (>2k)
402M	Macro #if statement syntax error
403M	Macro #elif statement syntax error
404M	Macro #elif statement sequence error
405M	Macro #else statement sequence error
406M	Macro #endif statement sequence error
407M	An empty char constant cannot be used with an #if macro expression.
408M	Include files are nested too deeply. (maximum <0%s>)
409M	No #endif error.
410M	A closing parenthesis ')' is missing from the macro parameter list.
411M	Unknown macro name, or missing parenthesis after macro name. (<0%s>)
412M	Unterminated string error.

15.1.3.5 501H – 599H

Error Code	Error Message
501H	<option name> option is repeated.
502H	Option string <option string> is too long.
503H	The -mt and -sea options cannot be used together.
504H	Input file must be a form of '*.sc'.
505H	Unknown embedded SQL statement type.

15.1.3.6 701L – 799L

Error Code	Error Message
701L	No CURSOR SENSITIVITY options are supported yet.
702L	No CURSOR INSENSITIVITY options are supported yet.
703L	No CURSOR ASENSITIVITY options are supported yet.
704L	WITH HOLD option is not supported yet.
705L	WITH RETURN option is not supported yet.
706L	READ ONLY option does is supported yet.
707L	ALTER COMPACT option is not supported yet.

Appendix A. Using Files and LOBs

This appendix explains how to use the file system with the BLOB and CLOB data types, so that data in files can be inserted into tables, or so that data from tables can be written to files.

Output Host Variables

When it is desired to select data from a BLOB or CLOB type column and store the data in a file, the following syntax is used to specify output host variables in the INTO clause of a SELECT statement:

Syntax

```
BLOB_FILE <:host_variable> OPTION <:file_type> INDICATOR <:indicator>

CLOB_FILE <:host_variable> OPTION <:file_type> INDICATOR <:indicator>
```

Arguments

<:host_varible>: This is a character-type variable containing the name of the file into which to store the data.

<:file_type>: This is an integer-type variable that is used to specify the mode with which to access the file in order to write data to the file. The following modes are available:

- APRE_FILE_CREATE: In this mode, a new file is created, and the data are written to the new file. If a file having the specified name already exists, an error will be raised.
- APRE_FILE_OVERWRITE: In this mode, an existing file is opened, and its contents are overwritten, starting from the beginning of the file. If no file having the specified name exists, a new file is created, and the data are written thereto.
- APRE_FILE_APPEND: In this mode, an existing file is opened for appending, that is, the data are written at the end of the file, after any existing data. If no file having the specified name exists, an error will be raised.

<:indicator>: This is an indicator variable that is used to check for NULL returned values or to get the length of the data stored in the file.

Example

[Example] The following example shows the use of the CLOB_FILE keyword and a file open mode option. In this example, the T_LOB table is queried, an `int` type column value is stored in the *sI1*

output host variable, and a CLOB type column value is stored in a file whose name is specified in the string *sI2FName*, which is opened in APRE_FILE_CREATE mode.

<Sample Program: clobSample.sc>

```
EXEC SQL BEGIN DECLARE SECTION;
  int sI1;
  char sI2FName[33];
  unsigned int sI2FOpt;
  SQLLEN sI2Ind;
EXEC SQL END DECLARE SECTION;

strcpy(sI2FName, aOutFileName);
sI2FOpt = APRE_FILE_CREATE;

EXEC SQL SELECT *
  INTO :sI1, CLOB_FILE :sI2FName OPTION :sI2FOpt INDICATOR :sI2Ind
  FROM T_LOB;
```

An example pertaining to BLOB data is in blobSample.sc, and similar to this example.

Input Host Variables

When it is desired to use an INSERT statement to insert all of the data from a file into a BLOB or CLOB type column, the following syntax for input host variables can be used.

Syntax

```
BLOB_FILE <:host_variable> OPTION <:file_type> INDICATOR <:indicator>

CLOB_FILE <:host_variable> OPTION <:file_type> INDICATOR <:indicator>
```

Arguments

<:host_varible>: This is a character-type variable containing the name of the file from which the data are to be read.

<:file_type>: This is an integer variable to specify the file access mode when reading data from the file. Only the following mode is available:

- APRE_FILE_ READ: Open the file for reading. If no file having the specified name exists, an error will be raised.

<:indicator>: This is an indicator variable that is used to specify that NULL data are to be input.

Example

[Example] The following example shows how to insert a new record into the T_LOB table after reading binary data from a file in APRE_FILE_READ mode.

<Sample Program: blobSample.sc>

```
EXEC SQL BEGIN DECLARE SECTION;
  int sI1;
  char sI2FName[32];
  unsigned int sI2FOpt;
  SQLLEN sI2Ind;
EXEC SQL END DECLARE SECTION;

sI1 = 1;
strcpy(sI2FName,aInputFileName);
sI2FOpt = APRE_FILE_READ;

EXEC SQL INSERT INTO T_LOB
  VALUES(:sI1, BLOB_FILE :sI2FName OPTION :sI2FOpt INDICATOR :sI2Ind);
```

Appendix B. Porting Pro*C Applications to APRE

Refer to this appendix when converting an application that was written using Oracle Pro*C/C++ so that it can be compiled using the ALTIBASE HDB C/C++ Precompiler.

Datatypes

This section describes the Oracle data types and the corresponding data types of ALTIBASE HDB.

Datatype Comparison Table

ODBC SQL datatype	Oracle	ALTIBASE HDB	Comments
SQL_CHAR	CHAR	CHAR	1-32000 bytes long
SQL_TIMESTAMP	DATE	DATE	
SQL_LONGVARCHAR	LONG	BLOB	Up to 2147483647bytes
SQL_INTEGER	INT	INTEGER	
SQL_FLOAT	NUMBER	NUMBER	
SQL_DECIMAL	NUMBER(P)	NUMBER(P)	1-38
SQL_DECIMAL	NUMBER(P,S)	NUMBER(P,S)	precision: 1-38 scale: -84 – 126
SQL_BINARY	RAW	BYTE	1-32000
SQL_VARCHAR	VARCHAR	VARCHAR	max 32000 bytes
SQL_VARCHAR	VARCHAR2	VARCHAR	max 32000 bytes

Embedded Functions

Numeric functions, date/time functions, character functions, data type conversion functions and built-in functions are provided in ALTIBASE HDB, just as they are in Oracle. This section explains which ALTIBASE HDB functions should be used in place of corresponding Oracle functions.

Built-in Functions Compared

The name, purpose, and method of use of each built-in function of ALTIBASE HDB is similar to its counterpart in Oracle.

The following built-in functions are supported in ALTIBASE HDB:

- Numeric Functions: ABS, ACOS, ASIN, ATAN, ATAN2, CEIL, COS, COSH, EXP, FLOOR, LN, LOG, MOD, POWER, RANDOM, ROUND, SIGN, SIN, SINH, SQRT, TAN, TANH, TRUNC, BITTAND, BITOR, BITXOR, BITNOT
- Aggregate Functions: AVG, COUNT, MAX, MIN, STDDEV, SUM, VARIANCE
- Character Functions: ASCII, CHAR_LENGTH, CHR, CONCAT, DIGITS, INITCAP, INSTR, INSTRB, POSITION, LOWER, LPAD, LTRIM, NCHR, OCTET_LENGTH, REPLACE2, RPAD, RTRIM, SIZEOF, SUBSTR, TRANSLATE, TRIM, UPPER, REPLICATE, REVERSE_STR, STUFF
- Date/time Functions: ADD_MONTHS, DATEADD, DATEDIFF, DATENAME, EXTRACT, MONTHS_BETWEEN, ROUND, LAST_DAY, NEXT_DAY, SYSDATE, SYSTIMESTAMP, TRUNC
- Type Conversion Functions: ASCIISTR, BIN_TO_NUM, CONVERT, HEX_TO_NUM, OCT_TO_NUM, TO_BIN, TO_CHAR, TO_DATE, TO_HEX, TO_NCHAR, TO_NUMBER, TO_OCT, UNISTR
- Miscellaneous Functions: BINARY_LENGTH, CASE2, CASE_WHEN,DECODE, DIGEST, DUMP, GREATEST, LEAST, ROWNUM, NVL, NVL2, SENDMSG, USER_ID, USER_NAME, SESSION_ID

For more information, please refer to the *SQL Reference*.

Managing Database Connections

This chapter describes the differences in the database connection and disconnection methods between Oracle and ALTIBASE HDB.

Connecting to a Database

The command that is used to establish a default connection is the same in Oracle and ALTIBASE HDB.

Oracle and ALTIBASE HDB are also similar in that multiple connections can be established if names are assigned to individual connections, and in that connection options can be set using the USING clause.

B.0.0.1 The CONNECT Statement

- Oracle

```
EXEC SQL CONNECT {:user IDENTIFIED BY :oldpswd :usr_psw }
[[ AT { dbname | :host_variable }] USING :connect_string ];
```

- ALTIBASE HDB

```
EXEC SQL [AT {conn_name | :conn_name}]
CONNECT <:user> IDENTIFIED BY <:passwd>
```

```
[USING <:conn_opt>[,<:conn_opt2>]];
```

B.0.0.2 Establishing the Default Connection

- Oracle

```
char *username = "SCOTT";
char *password = "TIGER";
char *connstr = "ORA817";
EXEC SQL WHENEVER SQLERROR
.
.
.
EXEC SQL CONNECT :username IDENTIFIED BY :password
  USING :connstr;
```

- ALTIBASE HDB

```
strcpy(username, "SYS");
strcpy(password, "MANAGER");
strcpy(connstr,"DSN=192.168.1.2;PORTNO=20310;CONNTYPE=1");
EXEC SQL CONNECT :username IDENTIFIED BY :password
  USING :connstr;
```

If the USING clause is not specified, the application will attempt to connect to an Altibase database on the same system.

B.0.0.3 Establishing a Named Connection

- Oracle

```
char *username = "SCOTT";
char *password = "TIGER";
char *connstr = "ORA817";
EXEC SQL WHENEVER SQLERROR
.
.
.
EXEC SQL CONNECT :username IDENTIFIED BY :password
  AT :db_name USING :connstr;
```

- ALTIBASE HDB

```
strcpy(user2, "ALTIBASE");
strcpy(passwd2, "ALTIBASE");
strcpy(connstr2,"DSN=192.168.1.12;PORTNO=20310;CONNTYPE=1");
strcpy(conn_name, "CONN2");
EXEC SQL AT :conn_name CONNECT :user2 IDENTIFIED BY :passwd2
  USING :connstr2;
```

Disconnecting from a Database

In Oracle, the EXEC SQL ROLLBACK WORK RELEASE statement is used to roll back any pending transactions and disconnect from the database in a single line of code.

This statement is also supported in ALTIBASE HDB.

B.0.0.4 Disconnection Statements

- Oracle

```
EXEC SQL COMMIT WORK RELEASE;
```

or

```
EXEC SQL ROLLBACK WORK RELEASE;
```

- ALTIBASE HDB

```
EXEC SQL COMMIT WORK RELEASE;
```

or

```
EXEC SQL ROLLBACK WORK RELEASE;
```

Host Variables

This section describes the differences between the host variables used with Oracle Pro*C and those used with the ALTIBASE HDB C/C++ Precompiler.

Host Variable Compatibility

Oracle		ALTIBASE HDB		Remarks
Database Column type	Host Variable C type	Database Column type	Host Variable C type	
CHAR	Char	CHAR	char/char[2]	single character
VARCHAR2(X) VARCHAR(X)	VARCHAR[X]	VARCHAR(X)	VARCHAR[X]	n-byte variable-length character array
CHAR[X]	char[x]	CHAR[X]	char[x]	n-byte character array
NUMBER	Int	NUMBER/ INTEGER	int/APRE_INT	Integer
NUMBER(P,S)	short int long float double	NUMBER(P,S)	short int/APRE_INTEGER long float double	small integer integer large integer float-point number double-precision float-ing-point number
DATE	char[n] varchar[n]	DATE	char[n] varchar[n]	n >= 20

Host Variable Declaration Section

The statements used to delimit the host variable declaration section are the same in ALTIBASE HDB and Oracle.

- Oracle

```
EXEC SQL BEGIN DECLARE SECTION;
/* Host variable declaration */
EXEC SQL END DECLARE SECTION;
```

- ALTIBASE HDB

```
EXEC SQL BEGIN DECLARE SECTION;
/* Host variable declaration */
EXEC SQL END DECLARE SECTION;
```

Using Embedded SQL Statements

This section compares the use of basic SQL statements (SELECT, UPDATE, INSERT, DELETE), cursor control SQL statements and dynamic SQL statements in Oracle Pro*C and the ALTIBASE HDB C/C++ Precompiler.

Basic DML Statements

Basic DML statements, for example the SELECT, INSERT, UPDATE, and DELETE statements, are executed the same way (i.e. using EXEC SQL) in both Oracle and ALTIBASE HDB.

Cursor Control SQL Statements

The fundamental method of declaring cursors is the same in Oracle and ALTIBASE HDB. They only differ in that Oracle supports the declaration of cursor variables in the host variable declaration section, just like host variables, whereas ALTIBASE HDB does not.

B.0.0.5 Cursor Declaration

- Oracle

```
EXEC SQL DECLARE cur_emp CURSOR FOR
  SELECT e_firstname, e_lastname, emp_job, salary
  FROM employees;
```

- ALTIBASE HDB

```
EXEC SQL DECLARE cur_emp CURSOR FOR
  SELECT e_firstname, e_lastname, emp_job, salary
  FROM employees;
```

B.0.0.6 Cursor Open and Fetch

The methods used to open cursors and fetch records are the same in ALTIBASE HDB and Oracle.

However, the error code types and values differ between the two products, which means that error-handling code written inside the FETCH statement will need to be changed. The support for the use of the WHENEVER statement to handle runtime errors (e.g. EXEC SQL WHENEVER NOT FOUND DO BREAK;) is the same in ALTIBASE HDB as it is in Oracle.

Oracle

```
EXEC SQL OPEN cur_emp;
if(sqlca.sqlcode != SQL_OK ) {
fprintf(stderr, "OPEN CSR ERROR%d\n",sqlca.sqlcode);
  close_db();
  exit(0);
}
for(;;)
{
EXEC SQL FETCH cur_emp
  INTO :emp_name, :job_title, :salary;
  switch(sqlca.sqlcode)
  {
  case 0:
    printf("emp_name : %s\n", emp_name);
    continue;
  case 1403: /* Not Found Data */
    break;
  default :
    fprintf(stderr, "FETCH CSR ERROR %d",sqlca.sqlcode);
    close_db();
    exit(0);
  }
}
```

- ALTIBASE HDB

```
EXEC SQL OPEN cur_emp;
if(sqlca.sqlcode != SQL_SUCCESS ) {
  fprintf(stderr, "OPEN CSR ERROR %d\n",sqlca.sqlcode);
  close_db();
  exit(0);
}
for(;;)
{
  EXEC SQL FETCH cur_emp INTO :emp_name, :job_title, :salary;
  switch(sqlca.sqlcode)
  {
  case SQL_SUCCESS:
    printf("emp_name : %s\n", emp_name);
    continue;
  case SQL_NO_DATA: /* Not Found Data */
    break;
  default :
    fprintf(stderr, "FETCH CSR ERROR %d",sqlca.sqlcode);
    close_db();
    exit(0);
  }
}
```

B.0.0.7 Closing Cursors

The use of the CLOSE statement to close a cursor is the same in both Oracle Pro*C and APRE.

- Oracle

```
EXEC SQL CLOSE cur_emp;
```

- ALTIBASE HDB

```
EXEC SQL CLOSE cur_emp;
```

Dynamic SQL Statements

ALTIBASE HDB supports Oracle Dynamic SQL Methods 1, 2 and 3, but not Method 4. In Oracle, both the syntax ":v[1...n]" and the question mark ("?") can be used as parameter markers within embedded SQL statements. ALTIBASE HDB only supports the use of the question mark ("?").

B.0.0.8 Method 1

- Oracle

```
char dynstmt1[80];
strcpy(dynstmt1, "DROP TABLE EMPLOYEES");
EXEC SQL EXECUTE IMMEDIATE :dynstmt1;
```

- ALTIBASE HDB

```
EXEC SQL BEGIN DECLARE SECTION;
char dynstmt1[80];
EXEC SQL END DECLARE SECTION;
strcpy(dynstmt1, "DROP TABLE EMPLOYEES");
EXEC SQL EXECUTE IMMEDIATE :dynstmt1;
```

B.0.0.9 Method 2

- Oracle

```
int emp_number;
char delete_stmt[120];
.
.
.
strcpy(delete_stmt, "DELETE FROM EMPLOYEES WHERE ENO = :v1");
EXEC SQL PREPARE sql_stmt FROM :delete_stmt;
emp_number = 10;
EXEC SQL EXECUTE sql_stmt USING :emp_number;
```

- ALTIBASE HDB

```
EXEC SQL BEGIN DECLARE SECTION;
int emp_number;
char delete_stmt[120];
EXEC SQL END DECLARE SECTION;
.
.
.
strcpy(delete_stmt, "DELETE FROM EMPLOYEES WHERE ENO = ?");
EXEC SQL PREPARE sql_stmt FROM :delete_stmt;
emp_number = 10;
EXEC SQL EXECUTE sql_stmt USING :emp_number;
```

B.0.0.10 Method 3

- Oracle

```
char sql_query[80];
int dno = 10;
char e_lastname[10];
strcpy(sql_query,"SELECT e_lastname FROM employees WHERE dno > :v1");

EXEC SQL PREPARE S FROM :dynstmt;
EXEC SQL DECLARE C CURSOR FOR S;
EXEC SQL OPEN C USING :dno;
for (;;)
{
  EXEC SQL FETCH C INTO :e_lastname;
  .
  .
  .
}
```

- ALTIBASE HDB

```
EXEC SQL BEGIN DECLARE SECTION;
char sql_query[80];
int dno = 10;
char e_lastname[10];
EXEC SQL END DECLARE SECTION;

strcpy(sql_query,"SELECT e_lastname FROM employees WHERE dno > ?");
EXEC SQL PREPARE S FROM :dynstmt;
EXEC SQL DECLARE C CURSOR FOR S;
EXEC SQL OPEN C USING :deptno;
for (;;)
{
  EXEC SQL FETCH C INTO :e_lastname;
  .
  .
  .
}
```

Execution Results and Status Codes

This section will explain the differences between Oracle and ALTIBASE HDB in the use of the SQLSTATE, SQLCODE and SQLCA variables to handle runtime errors.

SQLCA

SQLCA is a structure in which information about the results of execution of embedded SQL statements is saved. In ALTIBASE HDB, the supported elements of the structure are `sqlcode`, `sqlerrm.sqlerrmc`, `sqlerrm.sqlerrml`, `sqlerrd[2]` and `sqlerrd[3]`. Other SQLCA elements, such as `sqlwarn`, are implemented only in the Oracle SQLCA structure, and are not supported for use in ALTIBASE HDB.

B.0.0.11 SQLCA Declaration

- Oracle

```
EXEC SQL INCLUDE SQLCA;
/* or */
#include <sqlca.h>
```

- ALTIBASE HDB

  In APRE, this structure is defined by default, and does not have to be explicitly declared.

B.0.0.12 sqlca.sqlcode status

- Oracle

Status Code	Description
0	Success
> 0	No rows returned
< 0	database, system, network, or application error

- ALTIBASE HDB

Status Code	Description
SQL_SUCCESS	Success
SQL_SUCCESS_WITH_INFO	
SQL_NO_DATA	No rows returned
SQL_ERROR	
SQL_INVALID_HANDLE	

B.0.0.13 sqlca.sqlerrm

`sqlerrmc` and `sqlerrml` are implemented identically in Oracle and ALTIBASE HDB.

B.0.0.14 sqlca.sqlerrd[2]

- Oracle

  This element indicates the number of records that were affected by an INSERT, UPDATE, DELETE, or SELECT INTO operation. This number is cumulative.

- ALTIBASE HDB

  Unlike Oracle, in ALTIBASE HDB the number stored in this element is not cumulative. When an INSERT, UPDATE, or DELETE operation is performed, this element indicates the number of records that were affected. When a SELECT or FETCH statement is executed using an array-type output host variable, this element indicates the number of records that were returned.

SQLSTATE

SQLSTATE is used to store a status code, which is used to determine the kind of error or exception that has occurred.

B.0.0.15 Declaring and Using SQLSTATE

- Oracle

  In Oracle, SQLSTATE must be declared and the MODE=ANSI precompiler option must be specified when precompiling.

  ```
  char SQLSTATE[6]
  ```

- ALTIBASE HDB

  In ALTIBASE HDB, it is not necessary to declare SQLSTATE.

B.0.0.16 SQLSTATE Status Codes

The values of the SQLSTATE status codes and their meanings in Oracle differ from the ODBC standard. Therefore, it will be necessary to appropriately convert SQLSTATE status codes to the ODBC equivalents with reference to 8.4.2 Status Codes and the ODBC code table.

SQLCODE

SQLCODE is used to store error codes after the execution of an embedded SQL statement.

B.0.0.17 Declaring and Using SQLCODE

- Oracle

  In Oracle, SQLCODE must be declared and the MODE=ANSI precompiler option must be specified when precompiling.

  ```
  long SQLCODE;
  ```

- ALTIBASE HDB

  In ALTIBASE HDB, it is not necessary to declare SQLCODE. SQLCODE data type in ALTIBASE HDB is int.

B.0.0.18 SQLCODE Status Code Values

- Oracle

  The SQLCODE status codes are the same as for sqlca.sqlcode.

- ALTIBASE HDB

Status Code	Description
0	Upon successful execution of the embedded SQL statement, that is, when the value of sqlca.sqlcode is SQL_SUCCESS
1	When the embedded SQL statement is executed successfully but a warning is detected, at which time the value of sqlca.sqlcode is SQL_SUCCESS_WITH_INFO
100	When no records were returned as the result of execution of a SELECT or FETCH statement, that is, when the value of sqlca.sqlcode is SQL_NO_DATA
-1	When an error occurred during the execution of an embedded SQL statement, but there is no error code corresponding to the error. At this time, the value of sqlca.sqlcode is SQL_ERROR.
-2	When an attempt was made to execute an embedded SQL statement without first establishing a database connection, that is, when the value of sqlca.sqlcode is SQL_INVALID_HANDLE
The presence of any value other than the values listed above in SQLCODE is an error message indicating the occurrence of an error in the corresponding SQL statement.	

Commit Mode

This section explains the differences between ALTIBASE HDB and Oracle related to the commit mode, including the default commit mode, how to change the commit mode, and how to commit transactions.

Default Commit Mode

Oracle	ALTIBASE HDB
Non-Autocommit Mode	Autocommit Mode

Changing the Commit Mode

- Oracle

```
EXEC SQL ALTER SESSION SET AUTOCOMMIT = TRUE or FALSE
```

- ALTIBASE HDB

```
EXEC SQL AUTOCOMMIT ON
or
EXEC SQL ALTER SESSION SET AUTOCOMMIT = TRUE or FALSE
```

Explicit Commit

- Oracle

```
EXEC SQL COMMIT;
or
EXEC SQL COMMIT WORK;
```

- ALTIBASE HDB

```
EXEC SQL COMMIT;
```

When Executing a SELECT Statement in Non-Autocommit Mode

- Oracle

  There is no need to commit SELECT statements in Pro*C applications.

- ALTIBASE HDB

  SELECT statements need to be committed. Use EXEC SQL COMMIT to commit them.

Sample Programs

The following sample source code contains examples of the points described above.

Oracle

```
#include <stdio.h>
#include <stdlib.h>
EXEC SQL include sqlca.h;

EXEC SQL BEGIN DECLARE SECTION;
  char emp_name[21];
  char job_title[21];
  int salary;
  int emp_number;
EXEC SQL END DECLARE SECTION;

char uid[10] = "SCOTT";
char pwd[10] = "TIGER";

int main(void)
{
  int dynamic_emp_number;
  char dynamic_stmt[120];

  EXEC SQL CONNECT :uid IDENTIFIED BY :pwd;
  if ( sqlca.sqlcode != 0 ) {
    fprintf(stderr, "DataBase Connect Error : [%d]!!!", sqlca.sqlcode);
    exit(-1);
  }

  /* INSERT */
  /* value setting */
```

```
  emp_number = 10;
  strcpy(emp_name, "oracle1");
  strcpy(job_title, "oracle dba1");
  salary = 10000;
  /* INSERT DML */
  EXEC SQL INSERT INTO employees (eno, e_lastname, emp_job, salary)
    VALUES (:emp_number, :emp_name, :job_title, :salary);
  if ( sqlca.sqlcode != 0 ) {
    fprintf(stderr, "DataBase Connect Error : [%d]!!!", sqlca.sqlcode);
    exit(-1);
  }

  emp_number = 20;
  strcpy(emp_name, "oracle2");
  strcpy(job_title, "oracle dba2");
  salary = 10000;
  EXEC SQL INSERT INTO employees (eno, e_lastname, emp_job, salary)
    VALUES (:emp_number, :emp_name, :job_title, :salary);
  if ( sqlca.sqlcode != 0 ) {
    fprintf(stderr, "Insert Error : [%d]!!!", sqlca.sqlcode);
    exit(-1);
  }

  /* SELECT DML */
  emp_number = 10;
  EXEC SQL SELECT e_lastname, emp_job, salary INTO :emp_name, :job_title,
:salary
    FROM employees
    WHERE eno = :emp_number;
  if ( sqlca.sqlcode != 0 ) {
    fprintf(stderr, "Select Error : [%d]!!!", sqlca.sqlcode);
    exit(-1);
  }
  printf(" SELECT result : ename=[%s], job=[%s], sal=[%d]\n",
    emp_name, job_title, salary);

  /* UPDATE DML */
  emp_number = 10;
  salary = 2000;
  EXEC SQL UPDATE employees SET salary = :salary WHERE eno = :emp_number;
  if ( sqlca.sqlcode != 0 ) {
    fprintf(stderr, "Update Error : [%d]!!!", sqlca.sqlcode);
    exit(-1);
  }

  /* Cursor Create */
  EXEC SQL DECLARE cur_emp CURSOR FOR
    SELECT e_lastname, emp_job, salary FROM employees;

  /* Cursor Open */
  EXEC SQL OPEN cur_emp;
  if(sqlca.sqlcode != 0 ) {
    fprintf(stderr, "OPEN CSR ERROR %d\n",sqlca.sqlcode);
    exit(-1);
  }
  /* Fetch Cursor */
  for(;;)
  {
    EXEC SQL FETCH cur_emp INTO :emp_name, :job_title, :salary;

    switch(sqlca.sqlcode)
    {
    case 0:
      printf("Fetch Result : emp_name[%s], job[%s], sal=[%d]\n",
      emp_name, job_title, salary );
```

```
      continue;
    case 1403: /* Not Found Data */
      break;
    default :
      fprintf(stderr, "FETCH CSR ERROR %d",sqlca.sqlcode);
      exit(-1);
    }
    break;
  }

  /* Cursor Close */
  EXEC SQL CLOSE cur_emp;

  /* Dynamic SQL */
  strcpy(dynamic_stmt, "DELETE FROM EMPLOYEES WHERE ENO = :v1");
  EXEC SQL PREPARE sql_stmt FROM :dynamic_stmt;
  dynamic_emp_number = 10;
  EXEC SQL EXECUTE sql_stmt USING :dynamic_emp_number;

  /* Disconnect */
  EXEC SQL COMMIT WORK RELEASE;

  exit(0);
}
```

ALTIBASE HDB

```
#include <stdio.h>
#include <stdlib.h>

EXEC SQL BEGIN DECLARE SECTION;
  char emp_name[21];
  char job_title[21];
  int salary;
  int emp_number;
  char uid[10];
  char pwd[10];
  char dynamic_stmt[120];
  int dynamic_emp_number;
EXEC SQL END DECLARE SECTION;

int main(void)
{
  strcpy(uid, "SYS" );
  strcpy(pwd, "MANAGER");
  EXEC SQL CONNECT :uid IDENTIFIED BY :pwd;
  if ( sqlca.sqlcode != SQL_SUCCESS ) {
    fprintf(stderr, "DataBase Connect Error : [%d]!!!", sqlca.sqlcode);
    exit(-1);
  }

  /* INSERT */
  /* value setting */
  emp_number = 10;
  strcpy(emp_name, "ALTIBASE1");
  strcpy(job_title, "dba1");
  salary = 10000;
  /* INSERT DML */
  EXEC SQL INSERT INTO employees (eno, e_lastname, emp_job, salary)
    VALUES (:emp_number, :emp_name, :job_title, :salary);
  if ( sqlca.sqlcode != SQL_SUCCESS ) {
    fprintf(stderr, "DataBase Connect Error : [%d]!!!", sqlca.sqlcode);
    exit(-1);
```

```
  }

  emp_number = 20;
  strcpy(emp_name, "ALTIBASE2");
  strcpy(job_title, "dba2");
  salary = 20000;
  EXEC SQL INSERT INTO employees (eno, e_lastname, emp_job, salary)
    VALUES (:emp_number, :emp_name, :job_title, :salary);

  /* SELECT DML */
  emp_number = 10;
  EXEC SQL SELECT e_lastname, emp_job, salary INTO :emp_name, :job_title,
:salary
    FROM employees
    WHERE eno = :emp_number;
  if ( sqlca.sqlcode != SQL_SUCCESS ) {
    fprintf(stderr, "Select Error : [%d]!!!", sqlca.sqlcode);
    exit(-1);
  }
  printf(" SELECT result : ename=[%s], job=[%s], sal=[%d]\n",
    emp_name, job_title, salary);

  /* UPDATE DML */
  emp_number = 10;
  salary = 2000;
  EXEC SQL UPDATE employees SET salary = :salary WHERE eno = :emp_number;
  if ( sqlca.sqlcode != SQL_SUCCESS ) {
    fprintf(stderr, "Update Error : [%d]!!!", sqlca.sqlcode);
    exit(-1);
  }

  /* Cursor Create */
  EXEC SQL DECLARE cur_emp CURSOR FOR
    SELECT e_lastname, emp_job, salary FROM employees;

  /* Cursor Open */
  EXEC SQL OPEN cur_emp;
  if(sqlca.sqlcode != SQL_SUCCESS ) {
    fprintf(stderr, "OPEN CSR ERROR %d\n",sqlca.sqlcode);
    exit(-1);
  }

  /* Fetch Cursor */
  for(;;)
  {
    EXEC SQL FETCH cur_emp INTO :emp_name, :job_title, :salary;

    switch(sqlca.sqlcode)
    {
    case SQL_SUCCESS:
      printf("Fetch Result : emp_name[%s], job[%s], sal=[%d]\n",
      emp_name, job_title, salary );
      continue;
    case SQL_NO_DATA: /* Not Found Data */
      break;
    default :
      fprintf(stderr, "FETCH CSR ERROR %d %s\n",
        sqlca.sqlcode, sqlca.sqlerrm.sqlerrmc);
      exit(-1);
    }
    break;
  }

  /* Cursor Close */
  EXEC SQL CLOSE cur_emp;
```

```
    /* Dynamic SQL */
    strcpy(dynamic_stmt, "DELETE FROM EMPLOYEES WHERE ENO = ?");
    EXEC SQL PREPARE sql_stmt FROM :dynamic_stmt;
    dynamic_emp_number = 10;
    EXEC SQL EXECUTE sql_stmt USING :dynamic_emp_number;

    /* Disconnect */
    EXEC SQL DISCONNECT;

    exit(0);
  }
```

Appendix C. Sample Applications

This Appendix gives the location of the sample programs used in the manual.

Executing the Sample Applications

Elements

The $ALTIBASE_HOME/sample/APRE directory includes sample files, header files, schema creation files, and makefiles.

The list of included files is as follows:

```
argument.sc
arrays1.sc
arrays2.sc
binary.sc
connect1.sc
connect2.sc
cparsefull.sc
cursor1.sc
cursor2.sc
date.sc
declare_stmt.sc
delete.sc
dynamic1.sc
dynamic2.sc
dynamic3.sc
free.sc
indicator.sc
insert.sc
mc1.sc
mc2.sc
mc3.sc
mt1.sc
mt2.sc
pointer.sc
psm1.sc
psm2.sc
runtime_error_check.sc
select.sc
update.sc
varchar.sc
whenever1.sc
whenever2.sc
include/hostvar.h
include/hostvar2.h
schema/schema.sql
Makefile
```

Installation

When ALTIBASE HDB is installed, the $ALTIBASE_HOME/sample/APRE directory will be automatically created. For more information about installing ALTIBASE HDB, please refer to the *ALTIBASE HDB Installation Guide*.

Execution

The user can use the makefile saved in the $ALTIBASE_HOME/sample/APRE directory to create an executable file.

C.0.0.1 Compile

```
make file_name
```

[Example1] This example shows how to compile the delete.sc sample program.

```
$ make delete
apre -t cpp delete.sc
-----------------------------------------------
 APRE C/C++ Precompiler Ver 6.1.1.1
 Copyright 2000, ALTIBASE Corporation or its subsidiaries.
 All rights reserved.
------------------------------------------------

g++ -D_GNU_SOURCE -W -Wall -pipe -D_POSIX_PTHREAD_SEMANTICS -D_POSIX_THREADS
-D_POSIX_THREAD_SAFE_FUNCTIONS -D_REENTRANT -DPDL_HAS_AIO_CALLS -g -DDEBUG -
fno-implicit-templates -fno-exceptions -fcheck-new -DPDL_NO_INLINE -
DPDL_LACKS_PDL_TOKEN -DPDL_LACKS_PDL_OTHER -c -I/home/trunk/work/altidev4/
altibase_home/include -I. -o delete.o delete.cpp

g++ -L. -g -L/home/trunk/work/altidev4/altibase_home/lib -o delete delete.o -
lapre -lodbccli -lalticore -ldl -lpthread -lcrypt -lrt
```

C.0.0.2 Execution

```
./file_name
```

[Example2] This example shows how to execute delete, the executable file created using the delete.sc sample application, and how to check the result.

```
$ ./delete
<DELETE>
-----------------------------------------------------------------
[Scalar Host Variables]
-----------------------------------------------------------------
7 rows deleted
```

Table Information of the Example Programs

Please refer to Appendix A in the *SQL Reference*.

Appendix D. FAQ

Frequently Asked Questions

Why were incorrect data inserted into my database table?

The application I created using APRE generates data and inserts the data into a database table. However, I have noticed that my application inserts unexpected values. Why is this?

D.0.0.1 Answer

One of the things to keep in mind when using APRE to develop an application is whether it is appropriate to declare host variables as local variables or global variables. Please check whether you have declared all of your host variables properly.

Why will my APRE application compile in Linux but not in Solaris?

I can compile my ALTIBASE HDB application in Linux, but I can't compile it in Solaris. What is the problem?

When I execute `make clean`, the `make` operation encounters a fatal error at this point:

```
reader /user/rttech/sjyu/altibase_home/install/src/makefiles/wrapper_m
acros.GNU, line 113 Unexpected end of line seen
 ---> ifeq ($(exceptions),0)
        override exceptions =
      endif # exceptions
```

- OS Solaris 2.7
- Interface APRE C/C++ Precompiler
- Product altibase-SPARC_SOLARIS_2.7-32bit-compat5-2.6.3-release.tar.gz

D.0.0.2 Answer

The reason an error occurred when make clean was executed is because you did not use GNU Make. GNU Make is bundled with most Linux distributions, but in Solaris, it needs to be downloaded and installed manually. After you have installed GNU Make, you should be able to compile your application in Solaris.

GNU MAKE for Solaris can be downloaded from www.sunfreeware.com.

Can I get a sample showing the use of a general makefile?

I am assuming that the makefile in the sample directory that is created when ALTIBASE HDB is installed is a GNU makefile. I'm not sure how to go about using other makefiles. Can I get a sample showing the use of a general makefile?

D.0.0.3 Answer

The following sample makefile would be used to compile the sample project found at $ALTIBASE_HOME/sample/APRE/sample1.sc in a 64-bit Solaris 2.8 environment.

```
COMPILE.c = /opt/SUNWspro/bin/CC -mt -fast -xarch=v9 -xprefetch=yes -
DPDL_NDEBUG -c
LD = /opt/SUNWspro/bin/CC
LFLAGS = -mt -xarch=v9 -library=iostream,no%Cstd -L/opt/SUNWspro/SC5.0/lib/v9
-L/usr/lib/sparcv9 -xprefetch=yes -fast -L$(ALTIBASE_HOME)/lib
GOPT =
INCLUDES = -I$(ALTIBASE_HOME)/include -I.
LIBDIRS = -L$(ALTIBASE_HOME)/lib
LIBS=-xnolib -Bdynamic -lthread -lposix4 -ldl -lkvm -lkstat -lsocket -lnsl -
lgen -lm -lw -lc -Bstatic -liostream -lCrun
CC_OUTPUT_FLAG = -o

SRCS=sample1.c
OBJS=$(SRCS.cpp=.o)
BINS=sample1

SOBJS=$(SESS.cpp=.o)

%.c: %.sc
    apre $<

all: $(BINS)

sample1: sample1.o sample1.c
    $(LD) $(LFLAGS) $(GOPT) -o $@ sample1.o -lapre -lodbccli $(LIBS)

%.o: %.c
    $(COMPILE.c) $(INCLUDES) $(CC_OUTPUT_FLAG) $@ $<

clean:
    -rm $(BINS) $(SRCS) $(OBJS) core
```

An error occurred when attempting to link libraries in HP-UX. Why?

A link error occurred in HP-UX upon library linking.

I used the following C compiler options

```
$ cc +DA2.0W -I../include -I/user1/altibase/altibase_home/include/ -I/user1/
asn1/include -Ae -D_REENTRANT -DOAM -DSRC_LINE -DDEBUG -DDETAIL_DEBUG -g -c
dbinit.c
```

I then linked the resultant object files as follows

```
$ cc +DA2.0W -o MKTDBD dbfunc.o main.o util.o dbif.o shm_msg.o file.o
dbinit.o dbresult.o -L/user1/altibase/altibase_home/lib -L/user1/main/
KTSLEE/lib -lcom -lprice.1.1.0 -lodbccli -lapre -lxti -lpthread -lrt -ldld
```

D.0.0.4 Answer

From the execution results, it looks like you used a C compiler, rather than a C++ compiler, for the linking operation.

If you use a C++ compiler, the system library is automatically added during the compiling and linking operations. However, when using a C compiler, you have to add the system libraries manually, as shown below

```
LIBS += -ldl -lstd -lstream -lCsup -lm -lcl -lc
```

Then make the following changes

```
$ cc +DA2.0W -o MKTDBD dbfunc.o main.o util.o dbif.o shm_msg.o file.o
dbinit.o dbresult.o -L/user1/altibase/altibase_home/lib -L/user1/main/
KTSLEE/lib -lcom -lprice.1.1.0 -lodbccli -lapre -lxti -lpthread -lrt -ldld -
ldl -lstd -lstream -lCsup -lm -lcl –lc
$ cc +DA2.0W -o MKTDBD dbfunc.o main.o util.o dbif.o shm_msg.o file.o
dbinit.o dbresult.o -L/user1/altibase/altibase_home/lib -L/user1/main/
KTSLEE/lib -lcom -lprice.1.1.0 -lodbccli -lapre -lxti -lpthread -lrt -ldld
```

An error occurs when I use gcc to link my project. Why?

```
$ gcc -o OBJ/checkrep OBJ/checkrep.o -L/home1/shkim/src/SK_DLR_v1.0.0/alti-
base/lib -L/home1/shkim/src/SK_DLR_v1.0.0/ap/lib -ldlr -lpara -lapre -lodbc-
cli -lelf -lposix4 -lc -lxnet
Undefined first referenced
 symbol in file
kstat_close /home1/shkim/src/SK_DLR_v1.0.0/altibase/lib/libodbccli.a(idl.o)
gethostbyname_r /home1/shkim/src/SK_DLR_v1.0.0/altibase/lib/libodbc-
cli.a(connection.o) (Symbol included in /usr/lib/libnsl.so.1 of hint depend-
ing)
kstat_lookup /home1/shkim/src/SK_DLR_v1.0.0/altibase/lib/libodbccli.a(idl.o)
kstat_read /home1/shkim/src/SK_DLR_v1.0.0/altibase/lib/libodbccli.a(idl.o)
kstat_open /home1/shkim/src/SK_DLR_v1.0.0/altibase/lib/libodbccli.a(idl.o)
kstat_data_lookup /home1/shkim/src/SK_DLR_v1.0.0/altibase/lib/libodbc-
cli.a(idl.o)
```

D.0.0.5 Answer

The Sun compiler includes different system libraries during the linking operation depending on whether you are running Solaris 2.7 or 2.6. The system libraries may also vary depending on whether you use CC, cc, or gcc for the linking operation.

Although we cannot recommend any solution with 100% certainty, we suggest that you try linking your project using either cc or CC and test it thoroughly. If the trouble persists, please contact us again.

The only libraries that we provide are the libodbccli.a and libapre.a libraries. The other libraries are all system libraries, and can be used by linking to the system archive at /user/lib (the exact location of this directory may vary). This will help avoid collisions. The symbols to which -lodbccli and -lapre refer are all found in the system library, and thus the system library must also be linked.

If you want to compile using gcc, we also provide versions of the libodbccli.a and libapre.a libraries for use when compiling using gcc. Additionally, when linking, the following system libraries must be linked: -lthread -lposix4 -ldl -lkvm -lkstat -lsocket -lnsl -lgen -l iostream -lCrun -lm -lw -lcx and -lc.

If I want to query data in an MMDB on an authentication server from other servers, on which server should I compile the library file?

I understand that in order to query data in an MMDB on an authentication server from other servers, I will need to access the authentication server with an application written using APRE.

To accomplish this, do I have to put APRE on all of the other servers and independently make a library for the executable files on each server? Or can I just create the library on the authentication server, distribute it to the other servers, and link them to create executable files?

If I do it the first way, I have to put APRE on every server that accesses the authentication server, which is painful, and will be difficult to manage in the long term. If I do it the second way, that is, if I create a library on the authentication server, distribute it, and compile and link it on the other servers, will I encounter problems if the servers are different hardware and don't run the same OS?

I would appreciate a suggestion as to how to go about this, and am curious about how your other clients have tackled this problem.

Finally, please provide a sample makefile that I should use in such a scenario.

D.0.0.6 Answer

Unfortunately, when working with heterogeneous operating systems, there is no way to avoid installing the ALTIBASE HDB client module, which is required for compiling and linking, on all of the other servers. In the typical scenario, in which all machines are running the same OS, the program is compiled on a dedicated compiler machine or standard machine, and then only the library for executable files needs to be copied to the other servers. When working with a variety of operating systems, however, the linker must be available on all of the machines (because it refers to the system library for that OS).

The makefile is in the $ALTIBASE_HOME/sample/APRE directory. Be sure to use the makefile with the libapre.a and libodbccli.a libraries provided by us when linking. Additionally, the altibase_env.mk contains all of the essential information required to compile and link APRE projects.

A compile error occurred while I was testing a simple piece of source code. Why?

It seems to me that there is a C++ standard I/O conflict between ALTIBASE HDB and g++.

D.0.0.7 Answer

The following example shows how to use gcc to compile an application

```
$ apre -t cpp conn.sc
$ g++ -W -Wall -Wpointer-arith -pipe -D_POSIX_PTHREAD_SEMANTICS -D_REENTRANT
-fno-implicit-templates -fno-exceptions -fcheck-new -I${ALTIBASE_HOME}/
include -I. -c -o conn.o conn.cpp
$ g++ -W -Wall -Wpointer-arith -pipe -D_POSIX_PTHREAD_SEMANTICS -D_REENTRANT
-fno-implicit-templates -fno-exceptions -fcheck-new -I${ALTIBASE_HOME}/
include -I. -c -o main.o main.cpp
$ g++ -L. -L${ALTIBASE_HOME}/lib -o conn main.o conn.o -lapre -lodbccli -
lstdc++ -lsocket -ldl -lnsl -lgen -lposix4 -lkvm -lkstat -lthread -lpthread
```

What is wrong with the makefile shown below?

I created the makefile shown below but can't use it to compile my project.

```
#include $(ALTIBASE_HOME)/install/altibase_env.mk
COMPILE.c = /bin/cc +DA2.0W +DS2.0W -DPDL_NDEBUG
CC_OUTPUT_FLAG = -c
LD = /opt/aCC/bin/aCC
LFLAGS = -L. +DA2.0W +DS2.0W -Wl,+vnocompatwarnings -L$(ALTIBASE_HOME)/lib
GOPT =
INCLUDES = -I$(ALTIBASE_HOME)/include -I.
LIBDIRS = -L$(ALTIBASE_HOME)/lib
LIBS=-lxti -lpthread -lrt -ldld
SRCS=
OBJS=$(SRCS.cpp=.o)
BINS=altitest
apre=altitest.c
SOBJS=$(SESS.cpp=.o)

%.o: %.c
    $(COMPILE.c) $(INCLUDES) $(CC_OUTPUT_FLAG) $@ $<
%.c: %.sc
    APRE $<
all: $(BINS)

altitest: altitest.o altitest.c
    $(LD) $(LFLAGS) $(GOPT) $(INCLUDES) -o $@ altitest.o -lapre -lodbccli
$(LIBS)
clean:
    -rm $(BINS) $(apre) *.o core *.class
```

D.0.0.8 Answer

```
%.c: %.sc
     apre $<
```

As shown above, change APRE (in upper-case) to apre (in lower-case).

Why can't I link my project?

The precompile operation is successful, but the following error occurs during the link operation.

```
$ cc +DA2.0W -o MKTDBD dbfunc.o main.o util.o dbif.o shm_msg.o file.o
dbinit.o dbresult.o -L/user1/altibase/altibase_home/lib -L/user1/main/
KTSLEE/lib -lcom -lprice.1.1.4 -lodbccli -lapre -lxti -lpthread -lrt -ldld -
ldl -lstd -lstream -lCsup -lm -lcl -lc
ld Unsatisfied symbol "SESStmtCount" in file /user1/altibase/altibase_home/
lib/libapre.a[sesSqlcli.o]
1 errors.
*** Error exit code 1
Stop.
```

I am running HP-UX 11.0 on an HP L class server.

D.0.0.9 Answer

Change the order in which the -lodbccli and -lapre link options are specified.

Why do I need to relink my project in ALTIBASE MMDB 2.4.1?

I installed ALTIBASE MMDB 2.4.1p1, but the library versions are not correct, and I had to relink my project. I am running Dec v.4.

D.0.0.10 Answer

```
include $(ALTIBASE_HOME)/install/altibase_env.mk

CC = /usr/lib/cmplrs/cc/ld -o
INCLUDES = -I$(ALTIBASE_HOME)/include -I.
LIBDIRS = -L$(ALTIBASE_HOME)/lib -rpath /usr/lib/cmplrs/cxx -L/usr/lib/
cmplrs/cxx
LIBS = -lmm -lqp -lsm -lid -lpd -ltli -lrt -lpthread -lm -lcxxstd -lcxx -lexc
-lc
ALTIBASE_OBJS=$(.cpp=.o)
BINS_SERVER=altibase dbadmin checkServer createdb destroydb killCheckServer
restoredb shmutil
BINS_CLIENT=isql iloader audit sesc

all: $(BINS_SERVER) $(BINS_CLIENT)

altibase:$(ALTIBASE_OBJS)
    $(CC) altibase -g0 -O4 -call_shared $(LIBDIRS) /usr/lib/cmplrs/cc/crt0.o
/usr/lib/cmplrs/cxx/_main.o $(ALTIBASE_HOME)/lib/ALTIBASE.o  $(LIBS)

dbadmin:$(ALTIBASE_OBJS)
    $(CC) dbadmin -g0 -O4 -call_shared $(LIBDIRS) /usr/lib/cmplrs/cc/crt0.o /
usr/lib/cmplrs/cxx/_main.o $(ALTIBASE_HOME)/lib/dbadmin.o $(LIBS)

shmutil:$(ALTIBASE_OBJS)
    $(CC) shmutil -g0 -O4 -call_shared $(LIBDIRS) /usr/lib/cmplrs/cc/crt0.o /
usr/lib/cmplrs/cxx/_main.o $(ALTIBASE_HOME)/lib/shmutil.o $(LIBS)

createdb:$(ALTIBASE_OBJS)
    $(CC) createdb -g0 -O4 -call_shared $(LIBDIRS) /usr/lib/cmplrs/cc/crt0.o
/usr/lib/cmplrs/cxx/_main.o $(ALTIBASE_HOME)/lib/createdb.o $(LIBS)

destroydb:$(ALTIBASE_OBJS)
   $(CC) destroydb -g0 -O4 -call_shared $(LIBDIRS) /usr/lib/cmplrs/cc/crt0.o
/usr/lib/cmplrs/cxx/_main.o $(ALTIBASE_HOME)/lib/destroydb.o $(LIBS)

checkServer:$(ALTIBASE_OBJS)
    $(CC) checkServer -g0 -O4 -call_shared $(LIBDIRS) /usr/lib/cmplrs/cc/
crt0.o /usr/lib/cmplrs/cxx/_main.o $(ALTIBASE_HOME)/lib/checkServer.o
$(ALTIBASE_HOME)/lib/checkServerPid.o $(LIBS)

killCheckServer:$(ALTIBASE_OBJS)
    $(CC) killCheckServer -g0 -O4 -call_shared $(LIBDIRS) /usr/lib/cmplrs/cc/
crt0.o /usr/lib/cmplrs/cxx/_main.o $(ALTIBASE_HOME)/lib/killCheckServer.o
$(ALTIBASE_HOME)/lib/checkServerPid.o $(LIBS)

restoredb:$(ALTIBASE_OBJS)
    $(CC) restoredb -g0 -O4 -call_shared $(LIBDIRS) -g0 -O4 -call_shared /
usr/lib/cmplrs/cc/crt0.o /usr/lib/cmplrs/cxx/_main.o $(ALTIBASE_HOME)/lib/
restoredb.o -lmm -lqp -lsm -lid -lpd -ltli -lrt $(LIBS)

isql:$(ALTIBASE_OBJS)
    $(CC) isql -g0 -O4 -call_shared $(LIBDIRS) /usr/lib/cmplrs/cc/crt0.o /
usr/lib/cmplrs/cxx/_main.o $(ALTIBASE_HOME)/lib/libisqlobj.a -lodbccli -
lutil $(LIBS)
```

```
audit:$(ALTIBASE_OBJS)
    $(CC) audit -g0 -O4 -call_shared $(LIBDIRS) /usr/lib/cmplrs/cc/crt0.o /
usr/lib/cmplrs/cxx/_main.o $(ALTIBASE_HOME)/lib/libauditobj.a -lodbccli -
lutil $(LIBS)

iloader:$(ALTIBASE_OBJS)
    $(CC) iloader -g0 -O4 -call_shared $(LIBDIRS) /usr/lib/cmplrs/cc/crt0.o /
usr/lib/cmplrs/cxx/_main.o $(ALTIBASE_HOME)/lib/libiloaderobj.a -lodbccli -
lutil $(LIBS)

sesc:$(ALTIBASE_OBJS)
    $(CC) sesc -g0 -O4 -call_shared $(LIBDIRS) /usr/lib/cmplrs/cc/crt0.o /
usr/lib/cmplrs/cxx/_main.o $(ALTIBASE_HOME)/lib/libsescobj.a -lodbccli -
lutil $(LIBS)

clean:
    -rm $(BINS_SERVER) $(BINS_CLIENT) *.o core *.class
old:
    -mv ALTIBASE ALTIBASE.old
    -mv audit audit.old
    -mv checkServer checkServer.old
    -mv checkipc checkipc.old
    -mv createdb createdb.old
    -mv dbadmin dbadmin.old
    -mv destroydb destroydb.old
    -mv iloader iloader.old
    -mv isql isql.old
    -mv killCheckServer killCheckServer.old
    -mv restoredb restoredb.old
    -mv server server.old
    -mv sesc sesc.old
    -mv shmutil shmutil.old
```

Index